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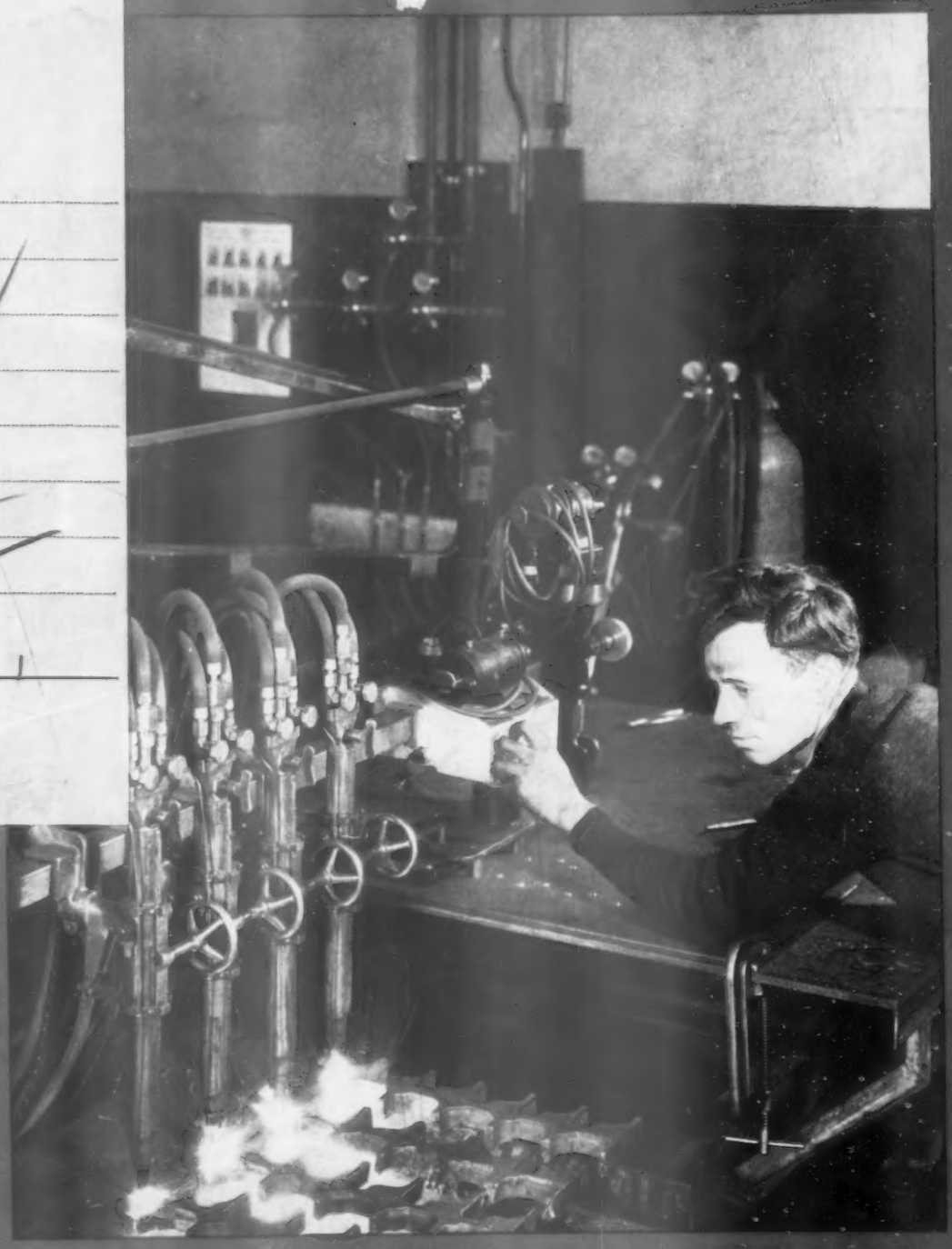
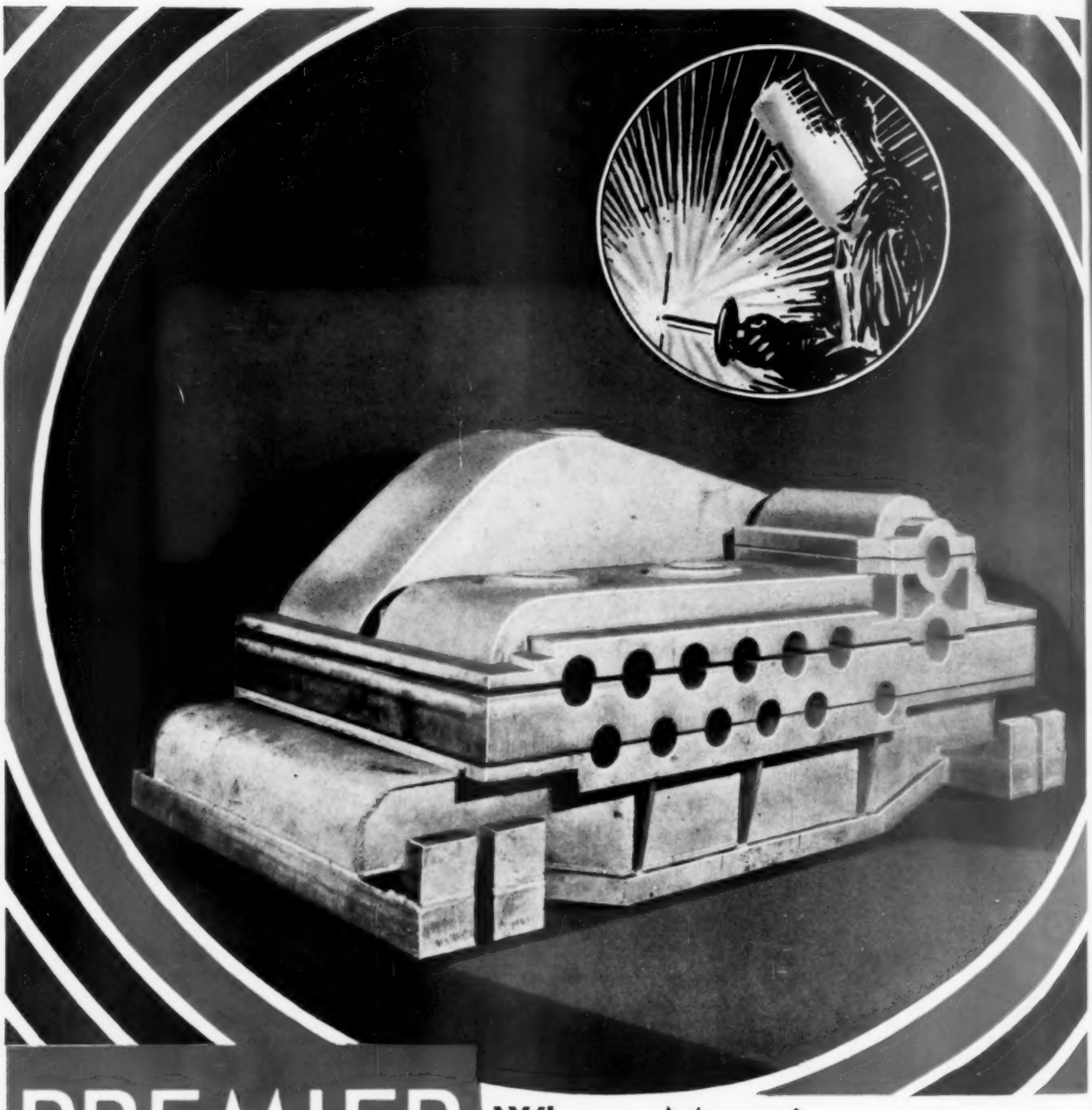


Forging Ahead with Improved Methods.

August, 1932



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Welding Wire

When a Minute's Delay Costs Dollars

A gear case broke—and a humming plant was forced into idleness. Every delay was costly, so Welding was called upon. Working from blueprints, the job was assembled in less time than it would have taken for a casting pattern! And—PREMIER Tested Welding Wire was used.

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The Welding Engineer

Volume 17 August, 1932 Number 8

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The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

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The Picture on the Cover*

"Forging Ahead with Improved Methods" (see page 22) is an article which forcefully illustrates the advantages that accrue to the modernized plant. Improvements in both product and service attract new customers and give the manufacturer a stronger hold on the old ones. Best of all, no operating difficulties were encountered in setting up an entirely new method of fabrication.

*Photo by courtesy of Air Reduction Sales Co.

This Will Help You Cut Costs

Swedox
Welding Rods and Electrodes

● *Swedox Service Facilities Include Complete Stocks of All Gas and Arc Welding Accessories.* ●

THE SWEDOX way is to work toward real economy instead of mere cheapness. We make actual tests to see how much time is consumed in laying down a pound of weld metal with one wire as compared with another. Often this test proves that the saving in time alone is several cents per pound. So it is foolish to let a difference of one or two cents per pound in the cost of the wire stand in the way of saving several times that amount in making the weld. Tests like this show how to get a lower cost per mile of welded pipe, or per hundred feet of seam on tanks and boilers, or any other welding job. Tell us about your work and we will be glad to help you with your costs.

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EDITORIAL

They'll Be at Buffalo

IN anticipation of the building up of a new purchasing power and a new demand in the not too distant future, manufacturers are thinking about the production of new kinds of freight cars, new kinds of automobiles, new types of factory built homes, new types of air conditioning equipment, new kinds of excavating equipment, and a multitude of other metal products. The men who are improving present products so as to have a better chance in the 1933 market, as well as those who contemplate an approach to this market with entirely new products, have to do some deciding very soon upon numerous production problems. What material to use? What manufacturing method to use? How to test the finished product? These are all pertinent and vital questions. Only once a year is there an opportunity to make a thorough investigation of raw materials, processes, fabricating equipment and testing equipment all under one roof in a few hours' time. This opportunity is presented at the National Metal Exposition in Buffalo. It is the outstanding opportunity of the year for industrial executives to get together with the men who can tell them the most about welding equipment, welding materials and welding methods. By the same token it is an equally important opportunity for the makers and sellers of welding products to get together with men from plants which are doing things, not only on account of the possibilities of making actual sales contacts, but for the more important purpose of getting first-hand information regarding the factory problems of 1932 and 1933. There is no other subject in the metal working industries which is attracting more attention and interest at the present time than that of welding construction. Buffalo will be the welding headquarters of the United States during the week of October 3rd. No matter what your interest in the subject may be, you will find in Buffalo the men with whom you would like most to discuss your own welding problems.

The Business Situation

WITH the business weather vane apparently turning around like the wheel of a windmill, many business men are at a loss to know whether or not there is any sign of definite improvement in business conditions that would justify making plans for a decent volume of orders for the last quarter. A real substantial investigation has been made by the Associated Business Papers, Inc., for the purpose of getting as close to the actual facts as possible, summarizing the bright spots in the industrial picture, and avoiding the spreading of any optimism not based on actual facts. The very first report on this investigation pointed to gains in no less than twenty different industries. Wherever there has not been an actual gain in orders, there has at least been an improvement in the viewpoint. The most encouraging gains have been found in the industries furnishing staples and necessities, such as foodstuffs, textiles, oils, shoes, etc. Construction work showed an actual gain in July over the previous month instead of the customary decline, in spite of the fact that residential building has not increased. Public construction is expected to be followed by more private construction. The welding industry keeps its eye on the steel market, and here is found no perceptible gain in actual orders for the immediate future. However, the steel industry seems to feel optimistic regarding fall business. As the steel orders increase, the volume of welding is bound to increase more than the layman would suppose. Only the closest observers have any conception of the progress which has been made in the welding industry during the past year. There has been almost universal tendency to judge the whole situation solely on the basis of the volume of work done. As a matter of fact, while the volume may have decreased, it is certain that the market possibilities have greatly increased. By the time steel production has increased to 30 per cent capacity, it will probably be found that the volume of welding is about equal to that which the industry enjoyed when steel production was at 50 per cent capacity before. Furthermore, while quantities of new applications were being discovered, all of the welding processes themselves have been improved. These improvements have been in the direction of better results and lower costs, making welded connections acceptable in many places where they were not universally acceptable before. The outlook is certainly improving.

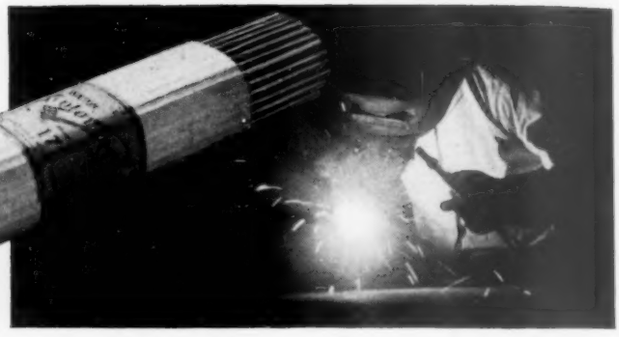
Modernizing and Sales

MODERNIZING of the production department by increased or improved welding facilities is not something to be kept secret on the assumption that the general public is not very well posted on welded construction. The publicity which the welding processes have received during the past few years has been largely of a beneficial and constructive nature. There has been much said about the greater acceptance of welded pressure vessels, the huge buildings which have been welded during the past few years, the advantages which these processes have offered to manufacturers of automobiles, and the many plans which have been made for welded construction in small residences. A great deal of this publicity has gone out through the newspapers and thereby has established a distinctly new impression of these processes in the minds of the public. It is therefore much more generally known that welded construction is dependable, safe and servicable. Under these conditions, the installation of equipment for welding a product which has previously been made in some other way, or the installation of more up-to-date equipment for producing a welded product of highest quality are both good subjects for advertising copy and sales talk. The American people really do not favor shoddy merchandise, although there has been much of it dumped on the market during the past year. Their preference is for quality. It pays to tell them about facilities which have been set up to produce quality goods. If welding methods used on any one product have been improved, the prospective buyers should be told about it.

UNIFORMITY

in Wilson Welding Wire

gives GREATER FREEDOM *in designs*



Uniformity **in the wire begets** ***Uniformity*** **in the weld. And** ***Uniformity*** **in the weld permits engineers to avail themselves fully of arc welding and to utilize every conceivable form and arrangement in their designs. Rolled steel can be used, the limitations of cast iron can be reduced, and the designer can distribute his metal to gain head space and to give the utmost strength with the least material and weight. Let the rod-for-rod** ***Uniformity*** **of Wilson Wire give you greater freedom in designs. Consult Wilson Welder & Metals Co. Inc., North Bergen, N. J.**

WILSON

ARC-WELDING MACHINES AND WIRE

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THE MONTHLY SYMPOSIUM

Tanks and Containers

High Pressure

In his talk before the recent Welding Conference, held at Alabama Polytechnic Institute, R. L. Scollard, Chief Engineer of the Welding Wire Division of the Gulf States Steel Co., spoke of a type of high pressure welding which will not stand high pressure. He referred to that particular kind of welding which is the result of high pressure on the part of the welding supervisor. Failures are quite likely to occur when this type of welding is done, and Mr. Scollard had on display the three welded tanks shown in Fig. 1 to illustrate his point. Tank No. 1 was

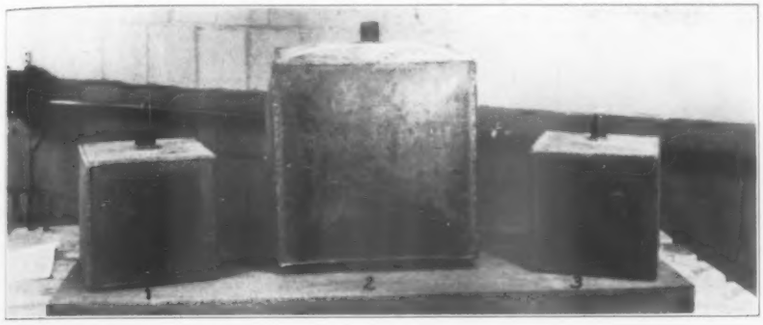


Fig. 1. Tanks Welded to Show Effect of Crowding the Operator.

Fig. 2. Result of Using "High Pressure" on the Welder.

welded in an hour and 27 minutes, including the tacking time. The same material and the same welding rods were used on all three tanks. This first tank was tested at 350 lbs. hydrostatic pressure and showed no fractures or leaks. Tank No. 2 was welded under somewhat similar conditions and gave satisfactory performance.

Practically the only difference between the work on the first two tanks was that in the case of tank No. 1 the operator was making a definite effort to take all the time necessary to make the welds as sound and as strong as possible, and to make no effort to set up a speed record. The second tank was welded with instructions just to do a good job. Tank No. 3 was welded under what Mr. Scollard refers to as the wrong kind of high pressure. The instructions were to make all possible speed and at the same time have the deposit present an outside appearance of being a good weld. The job was welded completely in 36 minutes, including tacking time. That is less than half the time it required to weld the No. 1 tank. When it came to a test, the welded seams on tank No. 3 opened up, as shown in the photograph, at 250 lbs. hydrostatic pressure. The results are quite apparent. While No. 1 would necessarily carry a slightly higher cost, the satisfaction obtained by a customer would naturally be such as to bring repeat business.

It was pointed out that matters like this have been touched upon too lightly by those in the welding business, and that the blame for failures has been placed on the operator or the material used or the machine used, when, as a matter of fact, the boss who brought pressure to bear on the men to get himself a reputation for fast production should be credited with the eventual failures. The three tanks described were welded with the same sheet material, the same welding rods, the same machine and by the same operator. The only difference was in the instructions governing the operation.

Rectangular Tanks of Everdur

The owner of a high powered gasoline yacht noticed last fall a smell of gasoline, and on examination found that the galvanized iron tanks were badly corroded. Gasoline tanks in a yacht of this size hold over 500 gallons each; so it is probably a matter of life and death to prevent the gasoline from getting out around the engines when they are running fast. Therefore, it is important that the tanks should be made of material which is not only strong, but has high resistance to corrosion.

After some discussion of materials to substitute for iron, it was decided to put in new tanks of Everdur, and F. L. Heughes & Company, Rochester, N. Y., had the job of building the new tanks. There are two of these, each 10 ft. long by 4 ft. high by an average of 2 ft. wide. Their shape permits them to fit roughly into the two sides of the stern, the space between them holding two engines.

It took three days to lay out the material, cut it to shape, form the flanges

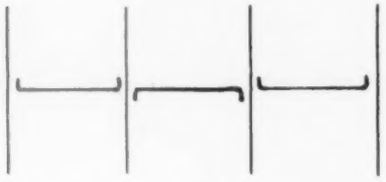


Fig. 1.

and prepare for assembly. Each tank has four baffle or swash plates which also serve as ties or stays to hold the long side plates from being forced out by the weight of the gasoline.

The upper half of three compartments of each tank had bottoms welded in to form reserve tanks. The gasoline in the larger compartments or group of compartments is pumped up into the reserve tanks, thus furnishing a constant pressure or head on the gasoline going to the carburetors. It required considerable study of the best type of welding joints to use for each seam to meet the stresses likely to arise in service.

The tank end plates were flanged all around and set in and welded to the ends of the long sheets by carbon arc welding, the edge of the flange being melted down on the side and bottom sheets which were backed with a copper strip. The baffle or swash plates were attached to the side and bottom sheets by inverted tee welds, using Everdur electrodes with reverse polarity, and backing up under the base sheets. Tack welds 1-in. long every 3 inches were used except where these welds closed seams of the reserve tanks and then the welds were made continuous. The reserve tank bottoms had their edges

flanged and these were welded to the surrounding sheets by the carbon arc with direct polarity. The flanges on the bottom of the middle compartment of the reserve tanks were put in extending downward (Fig. 1) so as to avoid making carbon arc welds on opposite sides of the same sheet at the same point, as this would probably have been too severe on the metal. This method also permitted the application of backing plates for all welding.

The most careful attention was given to cleanliness, as about the only cause of a leak in Everdur welding where the welding technique is good is oil or grease. All weld areas and edges were washed with gasoline and wiped with a clean cloth after drying. Observing this precaution and using the backing strip wherever possible, there is no difficulty in getting perfect welds in Everdur either by the metallic arc or carbon arc or the oxy-acetylene torch.

The two 10-ft. long bottom seams of both tanks were welded by the metallic arc process with reverse polarity. In each instance one edge was left slightly overlapping. This was later fused down with a carbon arc as were the ends of the tanks.

In the second tank considerable use was made of small Everdur angles, first welded to sides, bottoms and baffle sheets by carbon arc welding and later welded to the attached sheets similarly. Under test the second tank is said to have given as good results as the first tank, but there is a probability that there is less danger of burning thin sheets ($\frac{3}{32}$ in.) using tee welds and the metal arc process with good backing. The tanks were tested by filling with water and then putting on a pipe 10 ft. high and filling that to overflowing. Since each foot of elevation adds .434 pounds, this put a pressure of 4.34 pounds to the square inch, or 624.96 pounds to the square foot on the side sheets of each tank. There was quite an outward bulging on the sides between the swash plates and on the end plates which flattened out again on removing the pressure. This was regarded as being a far more severe test than any that could possibly come on the tanks in service.

These tanks were constructed just before the boating season started for this year, and the yacht has been in almost continuous service throughout the season, giving perfect service from the start, according to a report received this month from the owners. It was a somewhat unusual job because most of the tanks made of Everdur have been round tanks and the rectangular shape made it necessary to treat the construction as a complete new problem.

Building these tanks gave an excellent opportunity to study the conditions and to design tanks for holding gasoline on yachts and boats. It was suggested that on future tanks it might be well to dispense with the long large sheets and use sheets just enough wider than the space between swash plates to provide material for narrow flanges, and then assemble the tank by letting the edges of the swash plates come through to the outside between the edges of the flanges and then weld all the way around the tank with the carbon arc, fusing the three edges together with one weld, as indicated in Fig. 2. This type of welding is fast and good and economical and the slightly projecting edges that are left are ideal for holding the tank from end-wise movement, so that all the holding does not have to be done first at one end and then at the other.

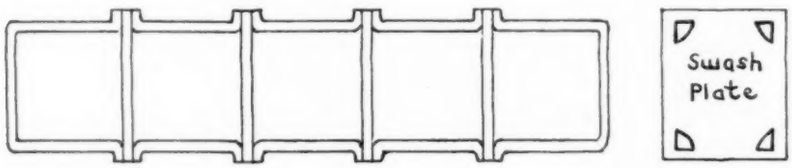


Fig. 2.

Annealing

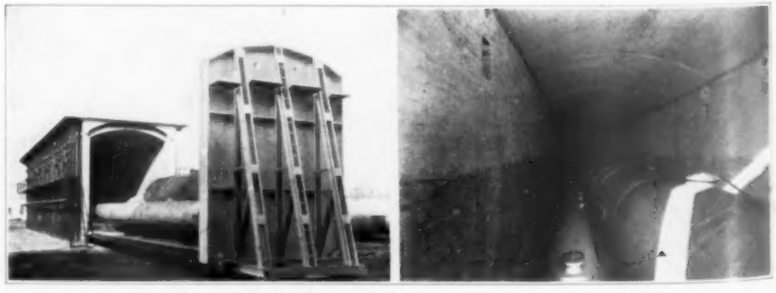
By M. L. Rogers

In previous issues of *The Welding Engineer*, the writer has described some of the interesting activities of the American Tank & Equipment Corporation, Oklahoma City. There is always something new of interest to be found there. On a recent visit I found that since the last call, a huge annealing oven had been installed and put into operation. This is apparently the largest annealing oven in the west and one of the largest in the world. The oven is 14 ft. by 14 ft. in section and 80 ft. long. The cost of installation was probably in the neighborhood of fifty thousand dollars, but Mr. C. B. Taylor, Superintendent of the plant, considers it not only well worth the cost, but practically indispensable under present conditions.

This huge oven was constructed so as to furnish a method of heating a welded tank of any size sufficiently to remove all stresses and put the metal in normal working condition. It is well-known that the great heat changes caused by welding are bound to be followed by the presence of residual stresses after cooling and that the annealing process serves the purpose of removing these conditions and distributing the stresses evenly throughout the welded product, leaving it in a condition of uniform strength with no weak spots. Some of the tanks and pressure vessels constructed in this shop are so large that the use of an oven of this size is the only way to do a proper annealing job.

The oven has a track running down the center for the full length, and an 80-ft. car runs on this track. The door of the oven is attached to one end of the car which, of course, is built completely fireproof. When preparing to operate, the car is loaded with whatever object or objects are to be annealed, then run into the oven until the door closes. The heat is then slowly turned on until the temperature rises to 1100 or 1200 degrees F. Then it is held steady for one hour for each inch of thickness of the metal; then allowed to cool slowly until the temperature has dropped to 400 degrees. Then the doors are opened and the annealed objects remain in the oven until they cool to a normal temperature. By this procedure the cooling process takes from ten to twelve hours. Slow cooling is an important factor in the annealing operation.

The walls of this huge oven are 12 in. thick with a dead air space. The entire oven is made of firebrick with a steel frame. The gas burners are installed in the top and so arranged that the hot air is circulated to provide an even temperature. The temperature is controlled at twelve points by scientific controlled instruments and an exact temperature record is kept throughout the entire annealing process.

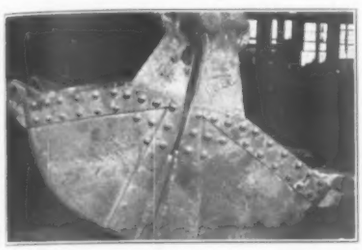


Exterior and Interior Views of Annealing Oven, Showing How End of Car Serves as One Door.

Maintenance Welding

Making It Work

Following a recent visit to the Ellis Garage and Machine Shop in Griffin, Georgia, R. G. Wilson, District Sales Manager of Burdett Oxygen Co., Atlanta, Ga., reported on what appears to be an unusual repair job. This was the reconstruction of a three-ton clam-shell bucket. The bucket was used for unloading gravel by a road construction company who was doing paving work in that vicinity. According to information obtained, it seems that the condition of the lips on the bucket was important. As sent out by the manufacturer the lips would become clogged with sand and would not close tightly enough. Mr. R. E. Ellis hit upon the following improvement:



The Reconstructed Bucket.

He took pieces of high carbon steel, the same material as the bucket itself, and added it all around on each bucket lip. This was accomplished by cutting the steel pieces to the proper length for the sides and bottom and they were then welded electrically to the lips of the bucket. About fifty pounds of 5/32-inch Una No. 155 arc rod was used and the extra edge was thereby firmly secured. After this operation, the lips were sharpened by beveling with a cutting torch. This sharpening process can be repeated many times until the material added is exhausted. Then the improvement described above can be done over again.

Hard Surfacing

Jack Silva of Juneau, Alaska, contributes these photographs which show among other things that the hard facing process has found its way to the far corners. The Eskimo is not hard facing. He is welding a 10-in. air line at a temperature of 6 degrees above zero. The pipe line welders in the mid-continent oil fields may envy him. One of the jobs illustrated is a crusher swing jaw which cost $2600.00 new. 52 hours welding time and 210 lbs. of Hascrome reclaimed this jaw at a total cost of $162.00. The other piece is a gyratory mantle which cost $1100 new. The repair required 93 hours of welding time and 350 lbs. of ¼ in. Hascrome rods. This work was done by Mr. Silva for the Alaska Juneau Gold Mining Company.

Pipe Line Welders in the Mid-Continent Fields May Envy This Eskimo Welder.

Mine Car Wheels

By J. Linn Johnson,
Wilkes-Barre Welding & Machine Co.,
Wilkes-Barre, Pa.

Results obtained, in the form of actual money savings, in reclaiming mine car wheels, has attracted considerable attention.

This phase of modern mine transportation has long been a bugbear to many operators; when we consider the high cost of the wheels used, the terrific punishment a car wheel receives, high speed motor traffic, the liberal use of sprags and sanded rails, it's quite surprising that the mine car holds up as well as it does.

It is common practice to buy cast mine car wheels costing about $5.00 each, weighing about 110 lbs., place them in service, and when discarded sell the discard as scrap.

Recently, however, more attention has been concentrated on this phase of colliery cost and we now find a method dveloped whereby these and discarded mine car wheels may be salvaged at a surprisingly low cost and put back into service. The repaired wheel is superior and gives longer life than a comparable new wheel.

The usual damage done to a mine car wheel is cone shaped hub wear and flat spots on the flange.

The cone shaped hub developes evidently from dust and grit getting into the bearings; i.e., track dust raised by motor transportation. This grit deteriorates the shaft, the journal box, and the wheel hub. The wheel hub particularly becomes affected, creating an enlarged end area and naturally causing the wheel (after a time) to become wabbly. The next phase is erratic motion, misalignment and loss of gauge. Derailment, material damage and injury are the results. Traction resistance also developes, causing loss of power as well as delays. All these causes have a direct bearing on transportation costs, which is one of the principal items in mine operation.

Flat spots on the wheel are caused by the wheel sliding on the rail; this may be produced by grit in the journal box (as defined above) or blocking.

All the car wheels discarded cannot be salvaged of course; some are allowed to remain in service so long after "flats" and "cones" develop that the salvage value is completely lost. However, 75% of the discarded wheels may be salvaged, and these are the ones in which we are interested.

The Wilkes-Barre Welding Company makes a specialty of this work. The method of repair is simple. The colliery superintendent isolates the wheels to be repaired. At the shop a neat electric welding job fills up the "flats"; next, an emery grinding wheel smooths the face or tread of the wheel and makes it concentric and flush with the other parts of the wheel. An electrode designed especially for this type of work is used.

When required, a hub drilling process trues up the hub and a special composition sleeve or bushing is pressed into the hub, trued up and the wheel is then ready for delivery and service.

From records kept of these replacements we learn the repaired wheels which have been returned to service outwear and remain in service longer than new wheels; this is possibly due to the new bushing of special composition and the reinforced tread.

When we consider the resistance or effort necessary to move a mine car with defective bearings or a flat wheel, we have a surprising percentage of man hours lost, especially at the place where a loss of change results; i.e., if the miner and his laborer is required to move a stiff car or a flat wheel cripple; he does not complete his loading in time to have a car loaded when the motor comes to replace his loaded with an empty car. Hence, this man is handicapped and his earnings naturally affected; or, if a contract miner loading a trip from a chute is required to stop loading in order to move a defective car —which is not an uncommon instance— unnecessary delays are caused and the whole loading process thrown out of gear.

The advantage the local welder has over the same process of repair on the part of the coal company is due to the inability of the company men to complete the same quantity and quality of

this work. Piece work comes in here; and where company men are paid an hourly rate there is no particular incentive.

Our shop developed this process about seven years ago, and almost every colliery in Luzerne County is having this work done here.

Structural Welding

Welded Truss Design One-Third Lighter

A radical change in truss design is represented by the welded roof truss consisting of continuous tension straps as shown in Figure 1. This new type of truss, developed by J. E. Webster, General Works Engineer of the Westinghouse Electric and Manufacturing Company, will be used immediately in a new building at the company's Derry plant. This building will require ten of the new trusses with a fifty-two foot span, and thirty with a thirty foot span.

In another specific case, a truss designed according to the best known present welding standards, already a saving over riveted construction, would weigh 3,700 pounds. The new design for the same load would weigh 2,380 pounds, a saving over the former welded design amounting to 35 per cent. The welding and assembly labor on the new design is less than that required on the older designs. This saving in weight is effected by designing the truss so that all members have uniform stress.

In construction the truss is an expansion of the kingpost principle. The 52 foot truss is composed of an upper compression member, three continuous tension straps, and twelve short struts, fabricated by combination butt and fillet welds.

The struts are welded to the top cord at purlin points and converge in pairs at the bottom cord, thus forming six isosceles triangles. The six diagonal tension members and the bottom cord of the truss (also tension members) are made from three steel straps. These straps, the ends of which are welded to the top cord at corresponding points on opposite ends of the truss, run diagonally downward and inward to the point of convergence of the two immediately adjacent struts, and then along the truss in the plane parallel to the top member, thus forming the bottom cord. This method of running continuous tension straps to corresponding points on opposite ends of the truss automatically increases the cross sectional area of the bottom member in proportion to the load which it carries.

A pair of trusses were subjected to a complete full load test as illustrated in Figure 3. Few roof trusses have ever been tested in such a thorough manner. Sixteen extensometers and one Ames dial gauge were employed. Two men conducted the tests with the aid of a crane loading the truss with increments of 6,600 pounds until the full load of 39,600 pounds per truss was reached. The test supplied valuable information regarding the behavior of trusses under full load and showed a relationship within 5 per cent between the calculated stresses and the measured stresses in the members.

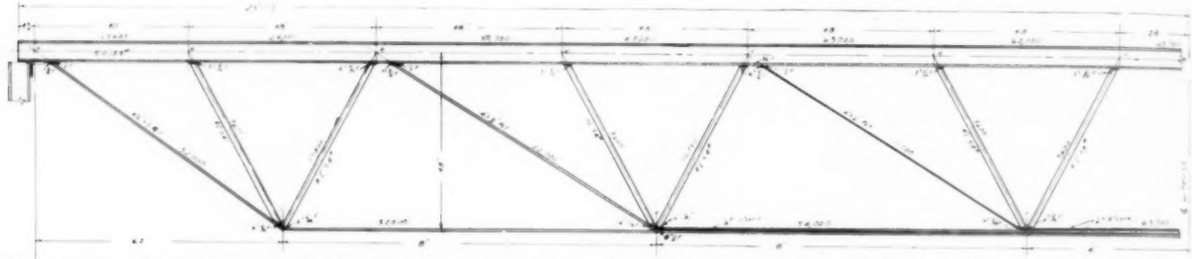


Fig. 1. Schematic Diagram of Welded Roof Truss Showing the Method of Construction and Theoretical and Actual Stresses in Each Member.

Fig. 2. Detail View of Junction of Tension Struts, Showing Fillet Welds.

Fig. 3. Measuring Stresses in Each Member of the Roof Truss Under Full Load.

Standpipe

Arc Welding Saves 20% When Employed on the Hamilton (New Zealand) Standpipe Reservoir*

By Rupert Worley, M.C. Assoc. M. Inst. C.E. and James Reginald Baird, Assoc. M.N.Z. Soc. C.E.

The Authors describe the conception and construction of a large standpipe reservoir in Hamilton, New Zealand, of exceptional interest in that it forms a most important advance in the application of electric welding to the reinforcement joints in ferro-concrete construction. The reservoir in question has a capacity of 3,000,000 gallons with a maximum diameter of 84 ft. and a minimum top water level of 85 ft. above foundation level. The project did not appear to be economically feasible by any of the usual methods of reinforced concrete construction, but by the liberal and unbiased application of arc welding to the problem, the designers have produced a structure admirably suited to the requirements, revolutionary in design and at such a low cost that the details of its construction are

*Paper presented before the International Association for Bridge and Structural Engineering, Paris Congress, May, 1932, and abstract by James Caldwell, London, Eng.

of great interest to all structural engineers.

Initial design indicated that a large elevated tank upon an elaborate system of braced columns, made all the more necessary by the somewhat close proximity of Hamilton to one of the major earthquake fault lines of the country. The design of a reinforced concrete watertower of such dimensions by the usual methods, contained so many factors of a doubtful nature, that other methods were sought.

In exploring the remarkably adaptible characteristics of the arc welding process the authors found a ready solution to such complex problems as leakages through the concrete, stresses created between wall and floor and the imperfect bonding between concrete already overstressed in tension and the steel reinforcement.

The design of this structure is not merely the employment of arc welding as an alternative to riveting or hooking and binding. Had these latter methods been employed it would have been necessary to adopt a design involving walls at least twice as thick, even to attempt to provide sufficient bonding between concrete and the steel with doubtful success. Bars would have had to be overlapped as much as four feet as against three inches, and many other features. The erection cost per ton of the steel by the welding method was less than two thirds the cost ruling locally for contracts employing other methods.

In all it is approximately computed that apart from the greater stability attained the cost of building a similar capacity standpipe by any other method would have been over £30,000 with grave doubts as to its success, against the actual recorded cost of £24,000 including research.

Portable Shop

The accompanying photo shows a rear view of the welding shop and yard of the Boulevard Welding Works, located on Anaheim Boulevard between Long Beach and Wilmington, California. The construction of the shop is 100 per cent welded.

The main structural framework of the shop, which is all welded, was recently erected by the owners and at a marked saving over any other type of construction. An added feature of economy in construction was effected in the utilizing of an accumulation of second-hand pipe which was acquired at a liberal discount, and served perfectly for the structural material.

The main supporting columns at the extreme outer sides and also at the sides of the center driveway, are of 6-inch oil well drill pipes which, by its thick walls provides great strength. The main lengthwise pipe placed over the supporting columns for holding the roof stringers, are of 4-inch drill pipe, while the stringers are of 2½-inch boiler tubing. All joints were cut to fit by the acetylene cutting torch.

The raised center structure comprising the cupola is constructed of 3-inch drill pipe for the lengthwise members, 2½-inch tubing was used for the upright braces. This cupola is four feet in height by about 12 feet in width, and comprises a very nice piece of welding. The structure is covered with No. 22 gauge galvanized corrugated sheet metal.

This Shop, Built by and for the Boulevard Welding Works, Can Be Moved Easily.

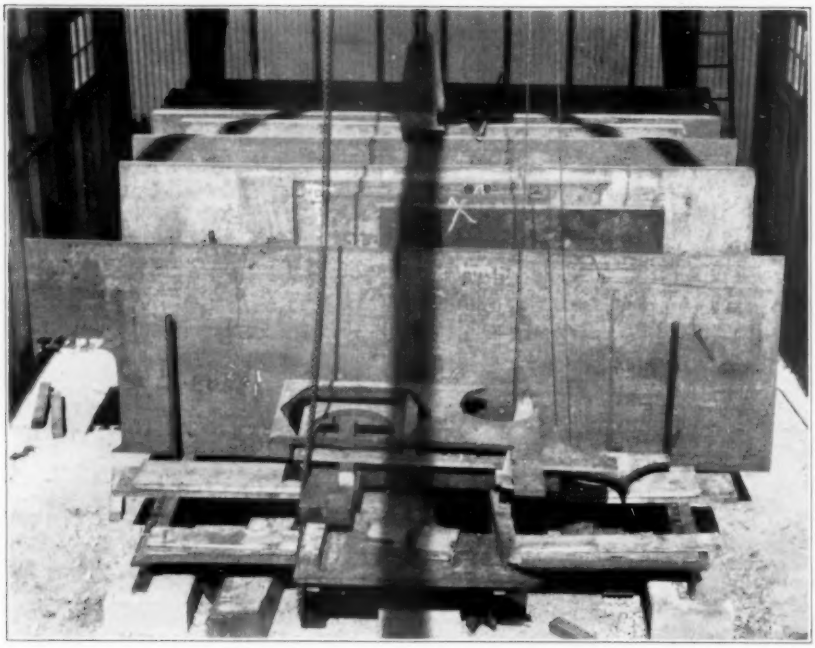
An interesting feature of this structure is the fact that it can be easily taken apart and moved, if occasion should ever require it. The supporting columns are secured by bolting to the foundation piers set in concrete. These piers are of the same size pipe as the supporting columns themselves, and have sleeves welded on at the top into which the upright columns fit. These columns are held securely in place by bolts extending through the collars. Thus by the removal of sixteen bolts, all of welded construction. In addition to this an all-welded metal telephone box and a "vault" for the safe keeping of torches, tips, regulators and other valuable equipment, made of welded heavy steel plate forms other interesting items of practical value which have been built at a great saving over any other method of acquiring. Cranes for handling heavy jobs about in the shop are conveniently built by welding the arms of the cranes to the heavy supporting columns of the structure. The Boulevard Welding Works is owned and operated by George Grunwaldt and George F. Wilson.

Hangar Floor

When the new airship hangar, at Sunnyvale, California, is completed, more than seven miles of welding will have gone into its construction. The dimensions of this giant structure, which is to house the new U. S. Navy dirigible "Macon," will be approximately 1200 feet in length by 308 feet in width by 225 in height. Not only will this hangar be one of the largest buildings in the world, but it will be the largest building in the world without pillars or posts to support it.

The laying of the sheet steel battle-deck mezzanine floors which run the entire length of the building, one on each side, is by far the largest job of structural welding ever performed in California. The floors consist of 2 feet by 12 feet steel plates ¾ of an inch thick, welded together. The splices between the ends of the plates are welded butt-strap joints, as are the longitudinal joints, except that in the latter case, the top flange of supporting 3" I-beams serve as the strap. The 3" I-beams are in turn welded to 20" I-beams. All the welds of the floor plates are continuous and the floor plate welds are ground flush with the top surface after the welds are completed. The welding of the I-beams and splice plates underneath the floor is done by means of a travelling scaffold of welded pipe construction.

The welding work is being done by the Brown Brothers Welding Company, of San Francisco, who have the subcontract from the Wallace Bridge and Structural Steel Company for welding the mezzanine floors and for welding all field connections where welding is required. The welding equipment being used on the job includes General Electric motor-driven and gas-engine-driven electric welding machines. General Electric type R and F electrodes are being used.



Quick Deliveries Are Possible on a Multitude of Orders From This Plate Stock.

Forging Ahead with Improved Methods

IMPROVED products, faster deliveries, lower costs and more satisfactory production on special orders are the operating advantages which have enabled the Danly Machine Specialties, Inc., 2104 S. 52nd Ave., Chicago, to make steady progress during 1932. This firm manufactures a complete line of standard and special die sets and accessories for die makers, and for years has maintained an enviable reputation for quality products and splendid service on deliveries. Up until a year ago, the cutting and welding processes had little or no part in the manufacturing of these products, but late in 1931 a study of these processes was made, cutting and welding equipment installed, and they became processes of major importance in the Danly plant.

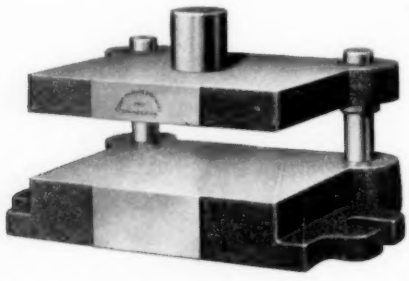


Fig. 1. Danly Regular Standard Die Set.

One of the simplest of the products of this plant is the regular standard die set. The die holder and punch holder were formerly cast of carbon steel, these castings ranging from 4x3" to 15¾x12", and in thicknesses from 1¼ to 4¾" in the regular standard die sets. The new method of fabrication is to make the die holder of .30 to .40 carbon rolled steel plate cut out with the automatic cutting torch. There are two methods of fabrication of the complete die holder. One method is to cut

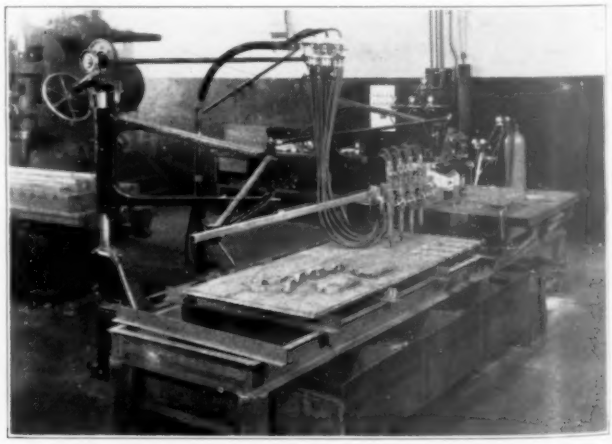


Fig. 2. The Oxygraph Installation in the Dandy Plant.

out the slotted ears from 7/8" plate and weld them to the thicker plate, and the other method is to cut the entire outside contour from plate of the required thickness and mill the whole piece down to the desired shape on a heavy duty milling machine which is a part of the plant equipment.

Even in these simplest products the new manufacturing method has been highly satisfactory. The annoyances and expense formerly caused by blow holes in castings has been eliminated. The manufacturer of such parts is at a real disadvantage when, after considerable machining time has been put into a job, a blow hole is encountered which makes it necessary to reject the casting and start in on another one. This disadvantage is, of course, increased when special orders are being put through with the expectation of making a certain delivery date in a minimum time. The use of .30 to .40 carbon rolled steel plate takes full advantage of the physical properties and uniformity of the rolled steel, giving greater strength with the same weight, and a die holder which is entirely free from internal strains due to pouring, the carbon content enhancing machinability.

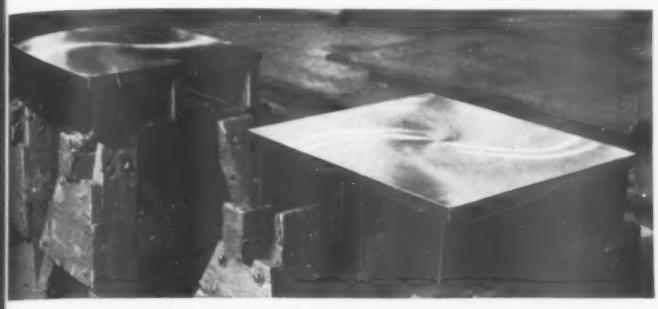


Fig. 3. On These Simple Plate Jobs the Customer Gets Speedy Service.

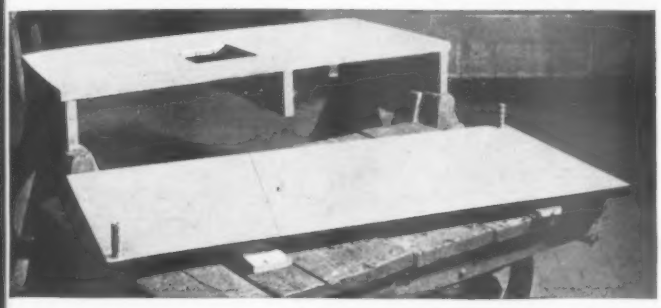


Fig. 4. A Hole to Be Cut in One Plate Presents No Problem at All.

All of these advantages show up with increased emphasis as the die sets become larger and the shapes more intricate, and there are listed in the Danly catalogue die sets which range in size up to 46x100", and thicknesses up to 5". Furthermore, it is worth noting that the tolerances in the finished product are small. Skillful designing and manufacturing and the use of hardened steel guide posts impart to them an operating precision which makes possible high production runs without damage to the dies or without sacrifice of uniformity of the parts produced.

The new manufacturing method has worked smoothly, efficiently and economically with practically no interruption of the regular routine and without making any appreciable inroads on the available floor space. At the same time, the installation has all of the convenience of any straight-line production layout. Just outside one end of the plant is a small building in which is kept a supply of plate stock ranging in thickness from 1/2" to 5". This stock of steel plate is only a few feet from the cutting department, and the craneways are so arranged that there is nothing to interfere with immediate delivery of the stock to the cutting machine. Just beyond the cutting machine are flat cars mounted on rails which deliver the cut shapes to the welding department immediately adjoining for assembly.

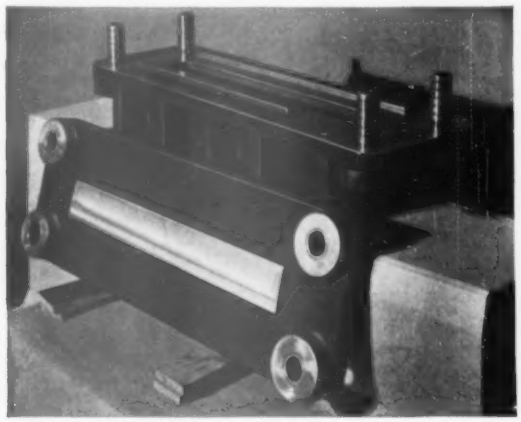


Fig. 5a. A More Complicated Die Set, Disassembled.

Fig. 5b. Same Die Set Assembled.

The cutting department is a thoroughly up-to-date installation. All of the cutting is done by an Airco D-B No. 4 Oxygraph carrying four torches. This is a stationary cutting machine designed for accurate cutting of all shapes from steel sheets and plates of any thickness up to 12" or more. The cutting torches are mounted on a tubular bar supported by ball bearing arms which provide for horizontal movement in any direction within the limits of the area covered. The motion of the torches is derived from a motor driven tracing device attached to the tubular bar or a magnetic drive following the contour of a cam of the desired shape. The necessity for a considerable amount of duplicate cutting led to the selection of the assembly of four 3-hose torches with hose

Fig. 6. Top of Die Set for Body Forming Press.

Fig. 7. Bottom of Same Set. This Is Built for Heavy Duty, Precision and Rapid Production.

connections to a header, which provides for the equalizing and distribution of the gases. A separate gas supply is furnished for a pilot flame which is used to light the torches. The operator thus can light the torches, turn on the cutting jets and operate for multiple cutting with the same ease and facility as when cutting with one torch. A large collection of templates for cutting standardized requirements has been made up by cutting and welding. These are convenient and durable and occupy very little space in the welding department.

With this equipment the Danly organization is enabled

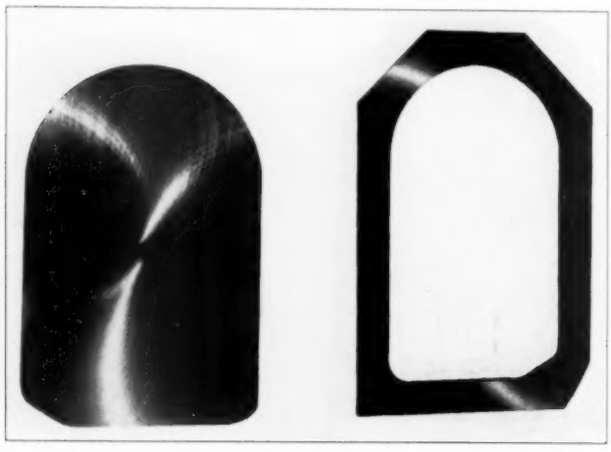


Fig. 8. Pressure Pad and Draw Ring Are Easy Cutting Jobs.

to offer from two to twenty-four hour delivery on a wide range of special die sets, special bolster sets and other specialized steel plate die parts. No patterns are required and no castings. Delays are eliminated and a better product is ensured. There is no limit to the variety because any sizes to fit any press built of any shape can be handled. Of course, in addition, this department can supply special steel shapes and welded units for a wide variety of purposes.

The illustrations have been selected to show variety in size and intricacy of the products which have been improved and produced with greater efficiency as a result of modernizing the plant equipment. Figure 3 shows two steel plate units with top faces machined. Such shapes can be handled in one day. These were required by a large manufacturer of a sheet metal product who wanted to produce some simple design parts on short notice and with a minimum of investment in machinery. Figure 4 is another steel plate die set. It will be noticed that the cut out is something which can be handled very easily by torch cutting. This is another unit which can be built up in a few hours at little cost. Figure 5a and 6 show a special steel plate die set now being used by an automobile manufacturer. The new torch cutting and welding department permits unusual delivery service on sets of this type. Figures 6 and 7 illustrate the use of this method on heavier and more complicated die sets, Fig. 6 being the top and Fig. 7 the bottom. It is obvious that in forming metals with such heavy duty equipment there are some terrific strains put on these pieces. In this particular case the nature of the work done is such that comparatively slender projecting pieces are a necessary part of the structure and there is little opportunity to support them with braces. The use of rolled steel is a distinct advantage here because the steel parts will bend before they will break as a casting would, and reconditioning is much more easily accomplished. Figure 8 illustrates a job in which no welding is involved. This illustration shows a draw ring and pressure pad cut from plate and machined to size. A mechanically controlled cutting torch easily takes care of the endless variety of shapes required on these sets and the work is so precise that only a very little machining is necessary.

It is apparent at a glance that there is no possible question as to the strength and serviceability of the finished products. On the contrary, fabricating from steel plate has produced a superior product. This is coupled with the ability to render the speediest possible service, and frequently at a worth-while reduction in cost.

Unusual Applications

In the current issue of *Fusion Facts*, published by the Stoody Company of Whittier, Calif., are mentioned a number of interesting miscellaneous applications of Stoody hard facing products. A lumber company uses common iron, hard surfaced, for hog anvil knives; a sand and gravel concern doubles the life of gravel screens; the teeth of a machine used for removing Bermuda grass from lawns are made to last three to five times as long as new ones; one concern saves some expensive pipe Y's following a hint received from a contractor who uses hard facing to prevent wear of concrete gun pipe bends; a Canadian mining concern salvaged three complete sets of tractor treads; an eastern concern is salvaging knitting machine parts and finds that the reclaimed parts outlast new ones at least ten to one at a cost less than that of replacement.

Shot Welding*—

A Forward Step in Resistance Welding

EIGHTEEN and Eight is not inherently stainless—its maximum resistance to corrosion is obtained only after a certain heat treatment. Without going into an elaborate dissertation on the complicated metallurgical aspects of this steel, it is sufficient to state that this heat treatment causes the various constituents of the steel, i. e. the nickel, the chromium, the carbon, the iron, etc. to be held in solid solution thus producing for the most part a homogeneous material.

The heat treatment necessary to produce this desirable condition consists in cooling the steel from some 1900 to 2000° F. After such treatment the metal is non-magnetic, very ductile and capable of being drastically cold worked. As is well known, however, any subsequent heating above room temperature effects the properties of the steel and extreme care and an intimate knowledge of the metallurgical phenomena which take place are necessary. Briefly, the reason for such care and knowledge is because of the fact that subsequent heating causes the homogeneous solid solution to be broken up with a concomitant precipitation of nickel and chromium carbides. The resulting heterogeneous metal is less resistant to corrosion, less resistant to fatigue stresses and there are indications that many of the other valuable characteristics of the metal are impaired. Such heating may occur and usually does in most types of welding under ordinary conditions, but the *time* at elevated temperatures is of equal importance, and in "shot welding" we can control the time at temperature very accurately.

The conditions favor electric spot welding. In the first place, the surfaces are clean and free of oxides; secondly, the electrical resistance is from 8 to 14 times that of carbon steel. Both conditions make for lower current value, so that commercial welders must be regulated down below normal in order to avoid burning. The welded spot has heretofore been usually surrounded by an annular ring of precipitated carbides, but these cannot be positively detected without the aid of a microscope after sectionalizing and etching with hydrofloric acid. This ring has been termed the *corona*. Its extent is known to be a function of time and current; its existence cannot be recognized by the eye. In fact, it is axiomatic that no one can tell a good or a bad weld by inspection. Surface condition means absolutely nothing, for fusion rarely extends to the outside of the sheets. The visible marking, more often than not, is due to arcing at the electrodes or secondary heat influence. However, all argument and evidence to the contrary, welds continue to be judged at face value.

Appreciation of these conditions has led the Edward G. Budd Manufacturing Company of Philadelphia, to develop a spot welding machine, the outstanding features of which are: absolute uniformity of current supply, use of high currents in a very brief, controllable time element and a recorder which supplies visible and audible record of performance. Results seem to justify differentiation, and the term *shot welding* has been coined.

With the use of the shot welder, corona-free welds can be consistently made, which automatically opens up a large structural field to stainless steel. Without such, there remains that element of doubt always associated with uncontrolled welding.

Shot Welding

In shot or spot welding, the diameter of the fused slug should have some reasonable relation to the thickness of the sheets to be joined. No closed section can economically suffer large welding flanges, for it is here that compression failure initiates. Shot welding encourages use of a narrow flange—much narrower than would obtain in a riveted connection—and, in consequence a spot not greater in diameter than three times the double thickness of material should be used. The flange, in turn, should be at least three spot diameters in width.

It will be appreciated that a large corona effect would reach the edge of the flange, where, experience shows, all fatigue failures start. A corona-free spot is essential, and such is obtained by short time of current dwell. There is really no need for large areas of fusion, since good welds will show twice the shear of a rivet of like diameter and can be spaced fifty percent closer together.

Shear is not the only tests for welds; they must be tough—tough enough to permit rotation thru at least 60°. Again, current and time relation will determine the character of the fused slug.

Pressure on electrode points is not significant except in two senses. There must be sufficient pressure to insure good point contact and a sufficient pressure of electrodes, or adjacent clamps, to bring the flanges closely together. Otherwise, the current diffuses over a circuitous path, and stainless being highly resistant, the amperage is reduced. The weld recorder must be relied upon to signal such event since the surface effect may be normal.

In this respect, practice is at variance with that of ordinary sheet steel where excessive pressure can result in no weld—just as can too little.

Portability of Equipment

Probably the one outstanding essential of a shot-welder designed for aircraft or other structural use is portability. It is rarely practical to progress the work past the apparatus. In the Budd machine, long lines of cables attach to hand or air tongs and these are dragged into almost inaccessible places. The machine can be rolled about the floor or lifted by cranes to any desired position. But, the current loss in cables and tongs is substantial and must be compensated for. Test welds made under each and every condition of use are alone determining.

Since the current and dwell are established by the machine, the operator has no choice in these matters. The inspector usually makes the settings for test welds

*Extracted from a paper on "Stainless Steel in Aircraft Construction," prepared by Col. E. J. W. Ragsdale, Research Engineer of Edward G. Budd Manufacturing Co., Philadelphia, Pa., and read by Mr. Albert Dean before the American Society of Mechanical Engineers at Buffalo on June. 6.

and then adjusts the recorder to the new value. Any variance of conditions which may make for over or insufficient current-time relation causes a bell to ring continuously until the machine is reset. Every weld made or failed is recorded on a tape, the length of line being a function of the I^2R. t which I represents amperes; R, resistance and t, time of dwell. This is the total heating value of the electric energy supplied. It is interesting to note that the heat which actually goes into a single shot-weld in two pieces of .012" material is but .035 B.T.U. This also explains how assemblies can be made without that distortion so troublesome in gas welding.

Design of Electrodes

While normal practice is to use two electrodes (one directly opposite the other, and both of similar shape) unusual conditions often dictate welding by indirection. One electrode may consist of a pad clamped to a sheet while the other is conventionally pointed and held against the member to be welded to that sheet. Again, both electrodes may be pointed and held against the member some distance apart, while a copper plate rests beneath the sheet. Here, two welds are made simultaneously, the current passing from one point thru member and sheet into the copper plate, then along the copper plate until it comes opposite to the other point where it exists thru sheet and member. This is made possible by virtue of the superior conductivity of the plate over that of the combined sheet and member of steel.

Both methods find application in shot-welding a corrugated member to a flat sheet such as is used in flooring or partitions. The sheet rests on a large copper plate and the only care is that electrodes are held far enough apart to insure sufficient resistance in the steel pieces.

Any of the many forms of indirect welding are apt to be more uncertain than in conventional practice. Both care and control must be exercised throughout the operation. Even then, good design will obviate the condition where the structure is important.

Welding thru several thicknesses is possible, and frequently done; nor do the pieces have to be of equal gauge.

The diameter of the spot is determined largely by current and time rather than by the size of the electrodes. Naturally, however, the spot cannot exceed in area that of the point.

So far, Elkonite has proven to be the most satisfactory tip material. A small piece is brazed to the point of each electrode—the smaller, the better, for Elkonite is a copper tungsten alloy and has much reduced electric conductivity. If tips are once well dressed they will last much longer. The arcing due to poor contact destroys them quicker than wear or deformation. Much prejudice exists with relation to the shape of the points, flat, conical or ball peened, with little convincing evidence. Where rapid welding is done on automatic machines, the electrodes should be water cooled.

Ideals in Structural Steel Shop Fabrication

(The sixth in a series on "The Ideal Application")

By Paul B. Covey†

I HAVE been up in the office of this imaginary, "ideal," shop quizzing and have found out some things.

In the first place—no man is allowed to do any welding on any production basis until he has been carefully tested—first, to see if he knows how to manipulate his arc readily and with assurance, if he knows what a good weld is and if his welds have a reasonably good appearance. Second, to see just how strong his welds actually are and how uniformly they run—and third, during a short period of probation, to determine as accurately as possible some things regarding the man's character. He must be conscientious, reliable and trustworthy—it must not be necessary to stand over him. He must be temperate—only a man with a steady eye, steady hand and steady nerves can be relied upon to deposit uniformly perfect welds.

Then, after the welder is actually put to work he is continually subjected to tests of various kinds. There are the tests always made after a welder has been away from the shop for any length of time to see if "his hand has lost its cunning". Then, there are the spasmodic tests, apt to occur at any time—at very uncertain intervals—in order to see if his work is uniform in character. Some tests are for appearance only—some for strength. But whatever the tests are they are all conducted in good spirit and the welder is made fully acquainted with the results found.

Well, here we are in the outer yard once more right where we found the material laid out for inspection—but now we find this same material is being spray painted prior to being shipped.

What? You thought it wasn't allowable to shop paint material to be field-welded? Why haven't you heard of the new paint just put on the market? You know that one of the reasons why this restriction has been applied is that no data has been available assuring the engineers controlling the welding industry that welds deposited on painted surfaces are equally strong to those made on clean or oiled surfaces. Also another great factor is that the fumes of the burning paint are unhealthy and it is felt unwise to subject the welding operators to such fumes.

But I understand that this new paint is of such a composition that it does not give off injurious fumes when burned and that the vapors given off act as an extra shield around the arc producing welds even stronger and more ductile than possible without the presence of such paint. So you can readily understand why the material is being painted before leaving the shop, particularly since it is much easier to do it here than in the field.

I must not forget another thing they told me in the office—they said that of all the material that passed through their shop there were not more than a couple of dozen different types of details. It seems that everything has been simplified to the nth degree and standardized most completely. This means, of course, a tremendous saving in the drafting room, in the templet shop and in the assembly work, for the fewer the number of different types there are and the simpler each type is the less time is required in studying and working out of details and the less chances there are for errors.

Next month—"Some General Ideals of Electric Welding Steel Structures."

†*Consulting Welding Engineer, Manchester, N. H.*

The Design, Layout and Construction of All Welded Gasoline Truck Tanks

By B. M. Shimkin†

Classification of Tanks and Allowable Weight of Vehicles

TANKS can be classified, as to capacity, as follows:

1. Small-size tanks, up to 500 gallons.
2. Middle-size tanks, 500 to 1,000 gallons.
3. Large-size tanks, 1,000 to 3,000 gallons.

The small and middle-size tanks are commonly used for the distribution of gasoline between short distances or inside the city limits. The large-size tanks are used for long distance delivery of gasoline and are much more economical for this purpose than either the small or the middle-size tank.

According to the present vehicle acts, the 3,000 gallon tank on a truck or trailer is practically the limit for highway use. The California Vehicle Act of 1929 permits only 22,000 pounds on vehicles having two transverse axles and four wheels, and 34,000 pounds on vehicles having three or more axles, no two of which are in the same transverse plane, and six or more wheels. The gross weight upon any one axle may be 18,000 pounds.

Cross Section of Tank

Years of experience have shown the oval tank as the most practical and the best looking. The oval has the lowest center of gravity compared with other types, and is very pleasant in appearance.

There are more than nine graphical methods of building an ellipse (oval), which can be found in any engineering reference book.

After numerous experiments we found that the most convenient method of building an ellipse for the tank is the method of four centers. This method gives a good, smooth shape and allows the utilization of any flange machine using an attachment to the flange machine, which will permit the use of the centers of the oval for flanging purposes. All other methods, where the radius of the oval continuously changes, requires a special flanging form for each separate oval. The building of such forms costs from $10 to $12, and thus increases the price of the tank.

The four-centers ellipse can be built as follows: Lay out on a horizontal line the large axis of the ellipse (a-b) (Fig. 1), and in the middle of this axis, on a perpendicular line, lay out a small axis of the ellipse (c-d). Then subtract graphically the small axis from the large one; divide the remainder into three equal parts. Lay out two of the obtained parts on each side of the center of the horizontal axis, and four such parts in the vertical directions from the same center. Now use these four points as the centers from which to build up an ellipse.

The capacity of the small and middle-size tanks with limited lengths can be increased by using the square shape with rounded corners. This shape cannot be recommended for large-size tanks, however, because of the very poor distribution of stresses created by the hydrostatic pressure and by the splashing about of the gasoline in the tank while on the highway.

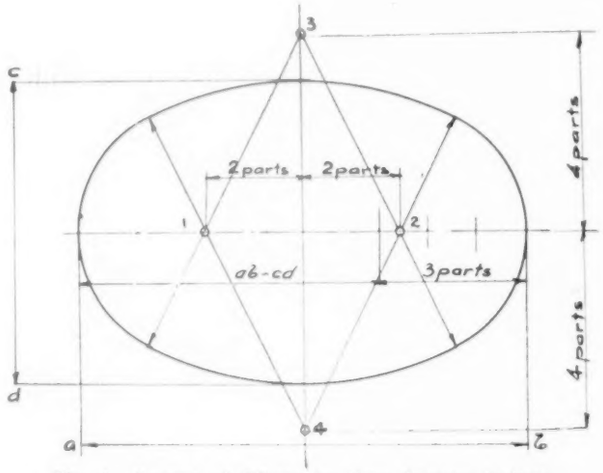


Fig. 1. Layout of Ellipse by Four Centers Method.

Material and Gauge

Open hearth steel or blue annealed steel is now usually used for truck tanks. Depending upon the size of the tank, the following thicknesses are used:

Capacity	Minimum thickness of metal
Up to 500 gallons	No. 14 gauge
Up to 1,000 gallons	No. 12 gauge
Up to 2,000 gallons	No. 10 gauge
Up to 3,000 gallons	No. 3/16 gauge

The heads, usually flanged, are made heavier on one gauge than on the shell.

†Engineer, Engineering and Sales Service Bureau, San Francisco, Calif.

Aluminum, which requires a greater thickness of material than steel, has come into use during the last few years. The metal, being about half as heavy as steel, allows the building of truck tanks which are lighter than steel ones, and permits the loading of 15 to 25 per cent more gasoline on the truck.

Construction of Truck Tanks

All truck tanks may be divided into two general types: the Single Compartment and the Multi-compartment tanks.

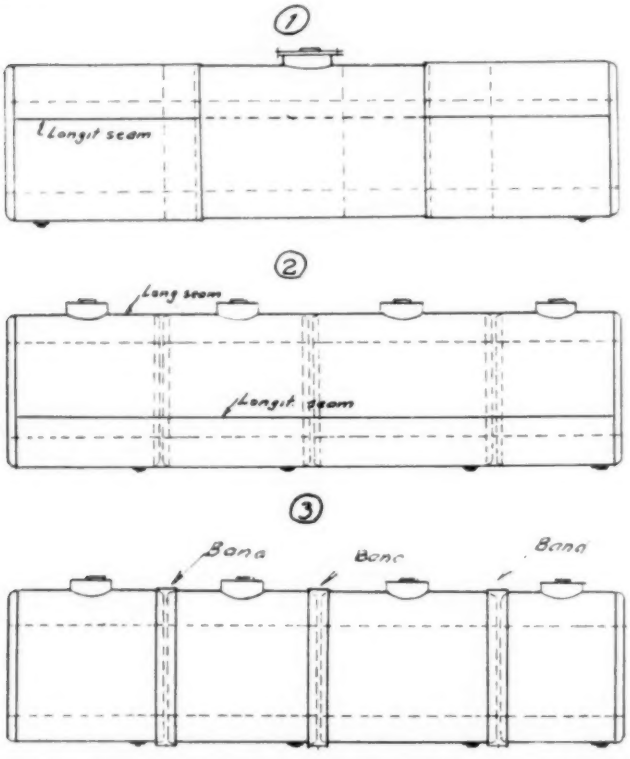


Fig. 2. Three Methods of Layout of Truck Tanks. (1) Single Compartment, (2) Multi-Compartment, (3) Independent Compartments.

The general principles of construction for both types of tanks are the same.

Shell and head seams can be welded, riveted-welded, brazed or riveted-brazed, or riveted-caulked. Lately gasoline tanks most commonly have welded or riveted-welded seams, for these types give the most satisfactory results, as they produce a gas-tight, one-piece truck-tank of good appearance; the production is cheap. Among the gasoline distributors, the all-welded truck tank is recognized as one of the best, and this is practically the only type now found on the market.

There are three methods of tank lay-out: The first, when the shell of the tank is built up from oval rings welded together by means of circumferential and longitudinal seams (Fig. 2-1).

The second, when there are no circumferential seams on the tank (except heads) and the three or more sheets are welded together on longitudinal seams only (Fig. 2-2).

The third, when several independent oval compartments are bolted together by means of clip angles, and the spaces between the compartments are covered by bands (Fig. 2-3).

In the second method the purchaser sometimes specifies that the bottom sheet be thicker than the side and top sheets. Such a specification is incorrect, because during the process of welding, one surface of sheets fits to the flash and by the difference in thicknesses creates an eccentric joint, which results in additional secondary stresses.

Butt-welded seams are used for small and middle-size tanks, and lap-riveted-welded seams in large-size tanks for the last method permits an easy fit to the body of the tank during the assembling and forms additional rigid bands which are very important in the large-size tanks. All shell seams are welded inside and outside. It is possible to use the butt-welded joint in the large-size tank also, but in that case it is necessary to use a special reinforced joint, as shown on Figure 3.

The use of one continuous flat band for reinforcement, as shown on Figure 4, is not recommended. A gasoline "pocket" may appear under such a reinforcement, and during repair, even after steaming the tank, an explosion under the torch may occur. This has been known to happen in several cases.

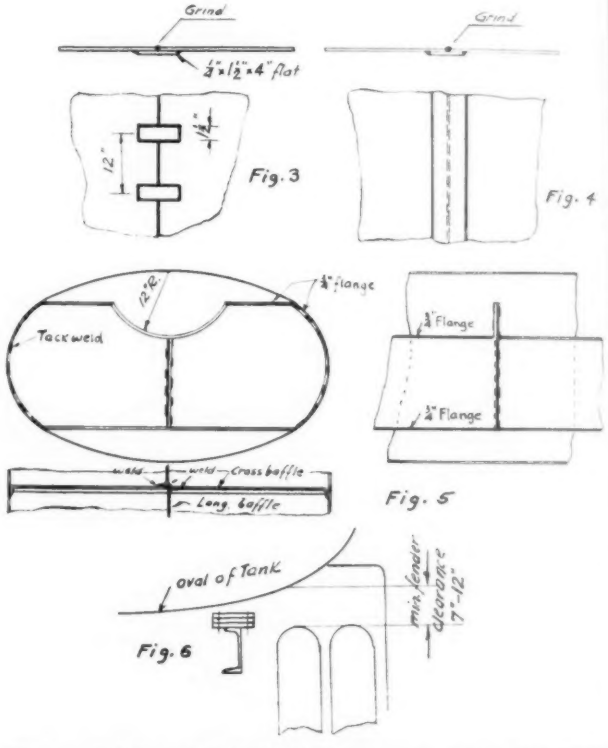
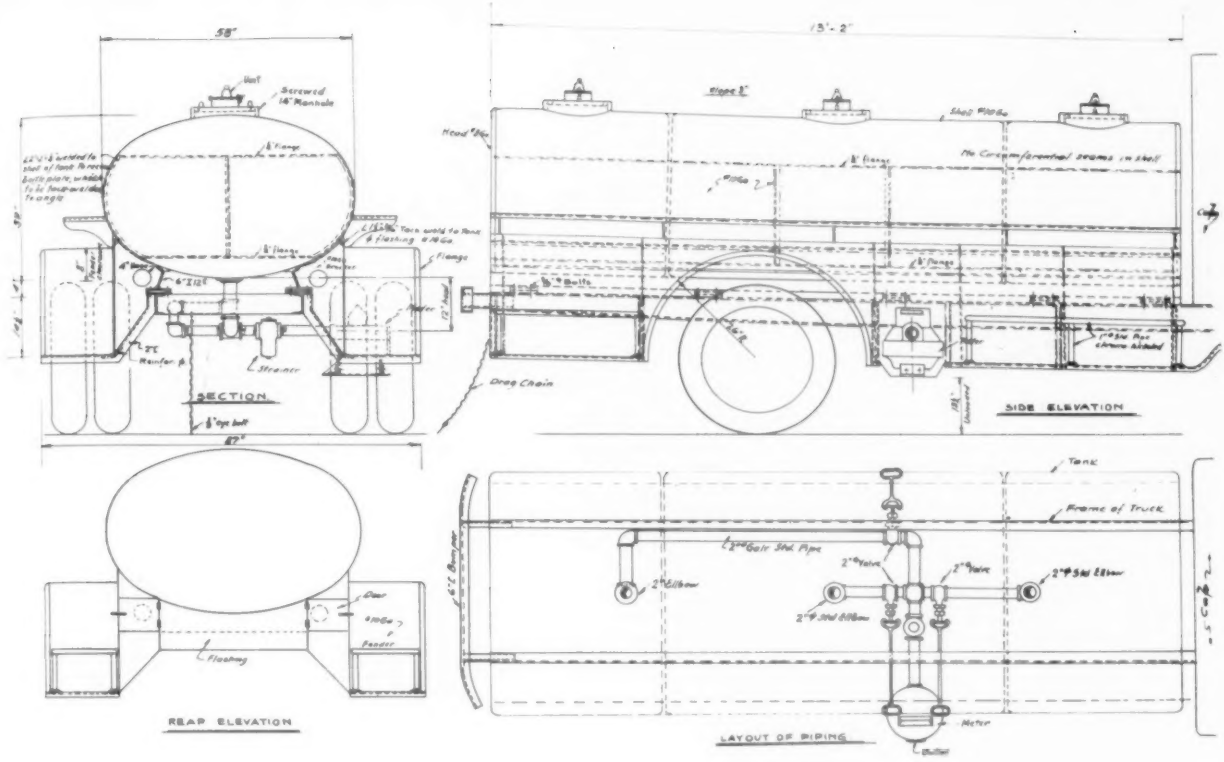


Fig. 3. Reinforced Butt Welded Seams for Large Size Tanks.
Fig. 4. Unrecommended Method of Reinforcing of Welded Seam.
Fig. 5. Baffle Construction for Small and Medium Size Tank.
Fig. 6. Layout of Fender Clearance on Truck Tank.

Cross and longitudinal partitions (baffles) separate by 4 to 5 feet all large compartments, which should be subdivided in order to prevent dangerous splashing about of the gasoline in the tank. The size and the type of the baffle depends upon the size of the tank.

For the small-size tank, the baffle may be built from the same metal as the shell, flanged on the sides and welded to the shell of the tank. The longitudinal baffles are usually 6 to 9 inches lower than the cross baffles because of the clearance for the manhole. They are also flanged on the ends and welded to the cross baffles (see Fig. 5).

For the middle-size tank it is better to use a light angle, solidly welded to the shell and the baffle of the same thickness as the heads which are riveted or welded to the outstanding leg of the angle (see Fig. 7).



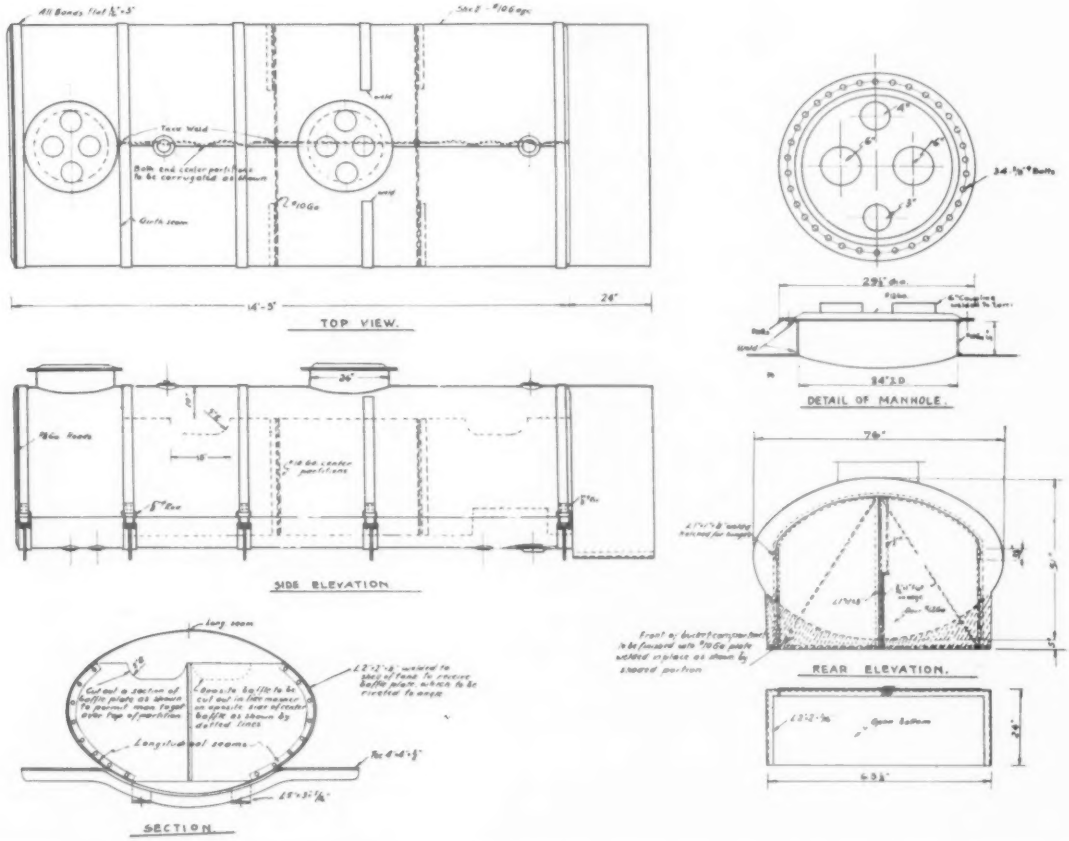


Fig. 7 (Above) 1300-Gallon Three-Compartment Tank with Running Boards and Cat Walks and Meter. Mounted on Longitudinal Beams.

Fig. 8 (Below) 2250-Gallon Two-Compartment Tank with Bucket Box. Mounted with Cross Beams.

The baffle angle stiffens the shell and makes a more rigid tank. It is not recommended to bolt the baffles to the angle, for the bolts become loose after a short time under vibration, thus being a source of great trouble since they can fall into the piping, the meter or the pumps.

For the large-size tank it is important to build up a triangle system of baffle stiffeners, so that the baffles themselves will be more rigid. But some designers use elastic longitudinal baffles with two or three corrugations in a baffle as shown in Figure 8. Such a construction transfers all splashing stresses to the heads. A very rigid triangle system of stiffness for cross and longitudinal baffles in a large tank can be recommended; it is illustrated in Figure 9.

The heads and balckheads, as mentioned above are to be one gauge heavier than the shell. Balckheads may be single or double. When there is a gasoline of a different kind in each compartment, double balckheads must be used. Usually an air space of ¾ to 1 inch between compartments prevents an intermixing of gasoline in case of a damage or a leak. A small hole at the bottom of such an air space helps to control leaking in the compartments.

Each compartment of the tank should be tested after welding and proved tight at a minimum air pressure of 5 pounds.

Openings in Tank

Manhole: There are two types of manholes for gasoline tanks, namely, the screwed and the bolted manholes. The screwed type of manhole is usually 14 inches in diameter, employing four threads to the inch, as shown in Figure 7. When a large manhole is required, the bolted type, with gas-proof gasket is used (see Figs. 8 and 9). Very often a large manhole requires a proportional relation between the body of the tank and the manhole itself.

The common rise of the manhole is three inches, very seldom six or twelve inches, above the highest point of the tank. Very large and especially single-compartment tanks require for the expansion of gasoline a dome of a capacity equal to three percent of the total capacity of the tank. The gasoline expansion in small and middle-size tanks will be taken up by the raised manhole, and according to the requirements of the National Fire Protection Association, no tank or tank compartment shall be filled in excess of 99¼ percent of the capacity.

Fillers and vents: Filler openings are usually located in the manhole and are not less than 4 inches in diameter, but are commonly 6 inches in diameter. These openings are standard pipe-threaded and have screwed caps with a minimum ¾" vacuum and pressure operating-vent. It is required by the National Fire Protection Association that "in addition thereto, venting facilities of such size and capacity as will safely relieve such internal pressure as may be created by exposure fires." There are many patented caps on the market which are built according to the above requirements.

Valves, faucets, emergency valves: Each compartment is equipped with a valve and faucet. All valves and faucets have threaded ends to permit a gas-tight connection with the piping and the hose extending to the fill-pipe.

To prevent the spilling of gasoline on the street in case of accident or fire, it is necessary to install an emergency valve inside the shell of each tank compartment, which is automatically kept closed, except during delivery operations.

Meter and strainers: Now tanks are very often equipped with a gasoline-meter and strainer. There are several types of strainers and meters on the market, but the most important thing for the tank designer is to distinguish the meters which require a certain "head" and the meters which can work without the "head" (gravity pressure).

The first type of meter needs a very carefully chosen location on the running board, which will be at a certain distance from the level of the street and sufficiently below the bottom of the tank for the "head" (minimum 12 inches). (See Fig. 7.) The second type of meter can be placed on the level with the bottom of the tank; this makes the layout of the mounting of the tank easier.

The gas meter is commonly located on the running board in front (see Figure 10) or in back of the rear wheel. The latter location can not be recommended because it is easily hit against the curb on sharp turns and in other accidents. The location of the meter in front of the rear wheels requires a horizontal mounting of the tank on the truck and a certain slope for the piping, so as to secure complete discharge from the compartments. This seems the most convenient and safest place for the meter.

Piping and Mounting of Tank

Purchasers at present like to have the truck-tank mounted as low as possible. This desire for low-mounted tanks is not only a fashionable demand, but an economical and competitive question because the truck-tank with a lower center of gravity can maintain a higher speed with more stability on the highway than the high-mounted truck.

Only by a very careful study and preliminary full layout with all clearances to the nearest parts of the truck obtained from the auto-designer, can there be made a good piping layout for a low-mounted truck-tank.

The mounting of a tank on longitudinal structural beams produces a considerable saving in elevation as compared with the mounting on cross-beams.

The mounting beams are cut off from the structural I beams or the full tee section, and are continuously welded on both sides to the shell of the tank. Then, by means of several pairs of bearing plates, some of which are solidly welded to the web of the beam and others to the frame of the truck. Between these bearing plates rubber pads, ¾ of an inch in thickness, are put in to reduce jarring on rough roads. This method of mounting can be seen very clearly on Fig. 11.

Regular machine bolts or U bolts (see Fig. 9) or long bolts with fish plates underneath the frame can be used to bolt the tank to the frame of the truck. By loosening the bolts such a tank can be easily removed from the truck. Experience has proven the strength of such a mounting construction, and has never shown any breakage or leaking along the lines of the beam welding or other places.

Large-size tanks require additional cross-bar ties and several brackets, which involves a large area of the tank shell in the distribution of stresses. These brackets (see Figure 9) must not be welded to the shell directly, but by means of an additional plate of the same thickness as the shell, and 2½ to 3 inches wide.

In case the tank, because of the construction of the truck and because of the large size of discharge pipes,

cannot be mounted close to the truck frame, a very high beam is required, sometimes 12 to 15 inches high with flanges 5 to 6 inches wide and weighing 40 to 60 pounds per lineal foot. There is no reason for placing on the truck such a heavy additional load, which considerably decreases the delivery capacity of the truck-tank and creates a permanent extra expense for gasoline to carry the excess load. In such cases it is better to use half of a 12 inch I beam raised up to the needed height by means of gusset plates, continuously welded around to the web of the beam and to the bearing plates. The thickness of these gusset plates is to be ¼-inch more than that of the web thickness of the structural beam. Details concerning that mounting are given in Figure 9.

Side Can-Racks

The drop panel type of can-racks is the most common. The usual section of this can rack is 12 inches wide and 9 inches deep, and extends along the full length of the tank. The hinged panels with spring latches are very convenient and the front surface is used for advertising purposes. The construction of the can racks should be light and consists of steel sheets of No. 20 gauge reinforced with hardwood strips to prevent sparking and the scratching of the tank by the cans. Details concerning the can-racks can be seen in Fig. 12.

Running Board

The running board is constructed from light channels

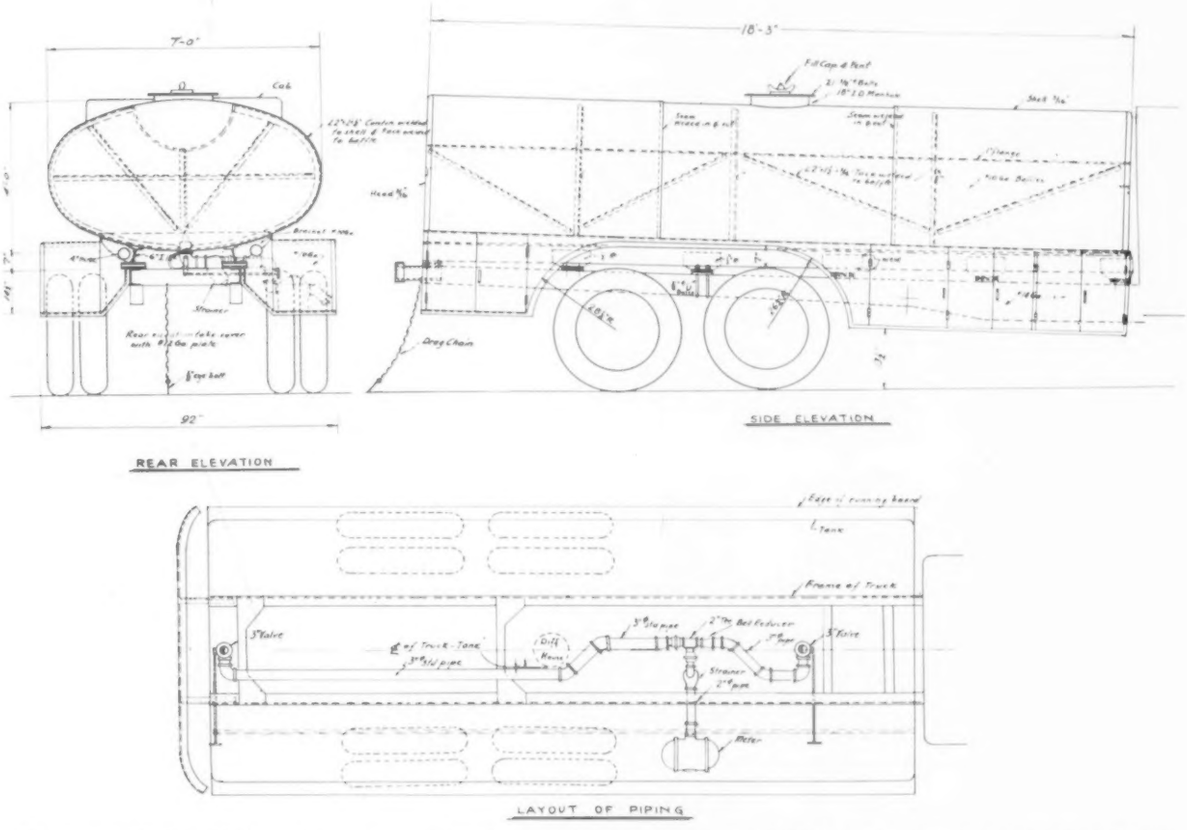


Fig. 9. 3000-Gallon Single-Compartment Tank with Running Board Boxes and Meter. Mounted on Longitudinal Beams.

The next point, which is necessary to keep in mind during the lay-out of the low-mounted truck-tank, is the fender clearance. This clearance (between the top of the fender and the tire) depends upon the type of the truck and the quality of springs, and varies from 7 to 12 inches for an empty tank.

In Figure 6 it is easy to observe that sometimes the clearance is governed by the distance between the oval of the tank body and the top of the tire, and that the location of the fender plays a secondary role. But at the same time the size and height of the longitudinal supporting beam depends upon this fender clearance. By changing the common springs to special "heavy duty" springs, this fender clearance can be cut to 6 to 11 inches.

If the allowable loading capacity of the truck is not fully used, or when the delivery of different kinds of lubricating oils is necessary, can racks, running boards with railing or barrel racks can be attached to the tank and truck.

bent in shape of brackets, reinforced by flats on bent lines and welded to the truck frame, as shown in Figures 7 and 9.

A No. 12 gauge checkered plate, rimmed with a light angle on the edges, is used as a cover for the running board. One-inch standard chrome-nickel pipe, used for railing, gives a luxurious appearance to the outfit.

The width of the running board is regulated by the general lay-out of the cross section of the truck-tank, and is limited by the width for vehicles allowed by the state. In California this limit is 96 inches.

Instead of railing on the running board, closed boxes with double side-swinging doors can be constructed. Such boxes give an impression of a very luxurious truck-tank.

Barrel Boxes

For the mounting of barrels, special racks on the sides of the tank are required. One of these racks is shown in

Fig. 12. The floor and the sides of the rack should be covered with No. 20-24 gauge sheets to protect the barrels from dirt. Two chains with quick-operating latches should be provided to hold the barrels in position.

This type of rack may be used on trucks where the distance between the cab and rear wheels is large enough to place the barrel in a horizontal position.

Rear Bucket Box

The sides of the bucket box are welded to the shell of the last compartment and, after grinding the welded seam outside, forms one continuous line with the shell of the tank. The depth of the bucket box varies from 14 to 24 inches and the width is equal to the width of the tank. Double side-swinging doors are recommended for tanks of all sizes (Fig. 12) and especially on small tanks. The single top-hinged door has the advantage of protecting the delivery man from rain and snow during the delivery operation, but cannot be used on small or low-mounted tanks, because it does not give sufficient head clearance. All-welded steel doors, built from No. 14 to 16 gauge cover and bar-channel frames are lighter than wooden doors. The lining of hard-wood strips inside the box prevents sparking and is shown in Fig. 12.

In a single-top hinged door a special hinged bar-support is used when open, to protect the driver from the possible banging of the door during deliveries.

Cat Walk

A cat-walk is often used for decorative purposes. It is usually built up from the checkered plate, and a light angle is attached to the bent-plate brackets on both sides of the tank, a little lower than a horizontal axis of the oval (Figures 10 and 13).

Hose Carrier

Each truck-tank should have a hose carrier on one or both sides of the tank. An oval shape of the tank permits the attachment of this tubing—usually 4 inches in diameter—along the longitudinal support beam with an extension in the bucket box, as shown in Figure 12, or with the door on the ends, as shown in Figure 7.

Figure 10 (Above)
Two-compartment, all-welded tank with screwed manhole, showing railing on running boards, meter, cat-walk and channel lift-up bumper.

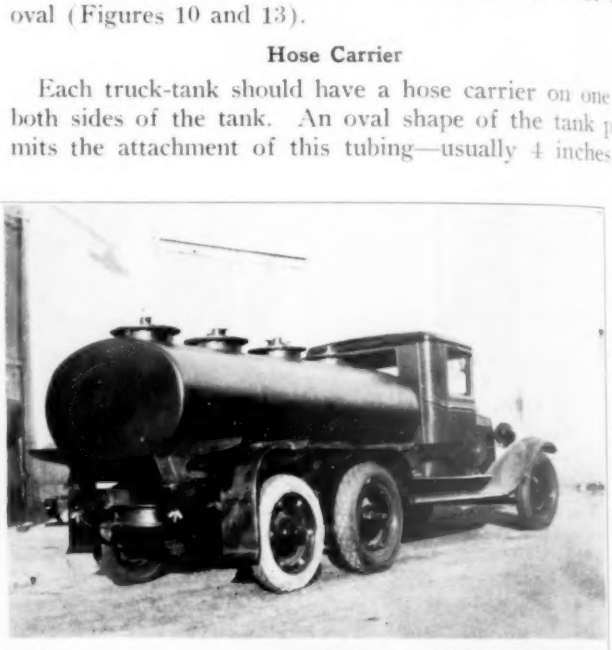


Figure 11 (Above)
Four compartment, all-welded tank with bolted manholes. The method of mounting on longitudinal beams and welded on brackets can be seen clearly.

Figure 12 (Below)
Same tank as on Fig. 10, with open doors and drop panel on can-rack. The construction and wood lining of the bucket box and can-racks can be seen clearly.

Figure 13 (Below)
Rear elevation of tank showing how a wide bumper can be used for advertising purposes.

Mud-Splash Plates

After the mounting of the tank on the truck, it is recommended to close all spaces between the tank and the chassis down to the running board with mud-splash plates of No. 20 or No. 24 gauge. These mud-splash plates not only really keep the truck clean on rainy days, but give a finished appearance to the outfit. Some of the mud-splash plates can be seen in Figure 10.

Bumpers

Each truck should be provided with a rear bumper to protect the draw-off valves or faucets in case of collision. It is necessary that this bumper be of the lift-up

type, so as to have sufficient room to fill cans during the delivery operations. A channel section is the most convenient and strongest form for the rear bumper. The flat surface of bumpers is usually used for advertisement (Fig. 13).

Drag Chain

To prevent any static charges, which may be generated by the splashing of gasoline or other causes, each tank should be equipped with a drag chain long enough to reach the ground at all times. It is very reasonable to end the chain with a round bar, which can not catch in some obstacle on the way and thus save the chain from breakage.

In the above described construction of truck-tanks, all members, such as the tank, chassis, axles and springs are connected and the drag-chain can be bolted to any point of the frame.

Sand Blasting and Painting

The outside surface of the truck-tank is usually painted with attractive colors and decorated by different emblems of the gasoline distributors.

For such painting the entire tank is sand blasted, in order to remove all scale and foreign matter which would affect the durability of the paint. Usually the tank is sand blasted inside and outside in the shop and painted with one coat of primer on the outside only. The finished painting of the truck tank is done by painting specialists.

Efficiency of Combined Riveted and Welded Connections

By Sterling Johnson†

IN connection with the design of a short plate girder in which it was difficult to develop the flange angles quickly enough with rivets, it was proposed also to weld along the toes of the angles. The question then arose as to whether the welds and the rivets would act in unison, and to what extent their respective shear-carrying values would be additive. While weld metal has been used to some extent in reinforcing old riveted structures, no test data showing the efficiency of such a combination was known to be available.

Test Program—The tests to develop this question were limited by the capacity of the testing machine available, to about double the breaking strength of a 7/8" rivet in double shear. The specimens were therefore so designed as to break in the connections at such a value. The details of the test pieces are given in Figures 1 and 2 and represent respectively:

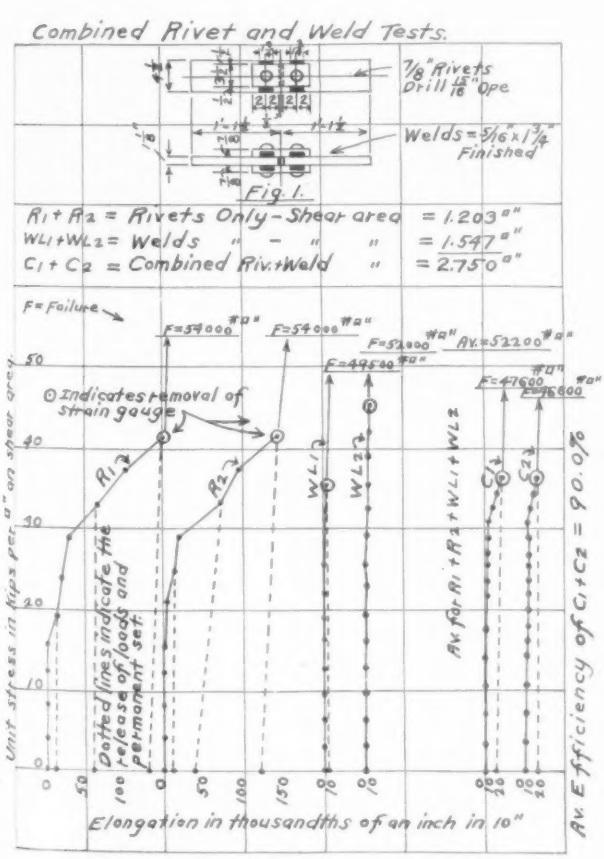

Combined Rivet and Weld Tests.
7/8" Rivets Drill 15/16" ope
Welds = 5/16 x 1 3/4" Finished
Fig. 1.
R1 + R2 = Rivets Only - Shear area = 1.203 "a"
WL1+WL2 = Welds " - " " = 1.547 "a"
C1 + C2 = Combined Riv.+Weld " = 2.750 "a"
F = Failure
Indicates removal of strain gauge
Dotted lines indicate the release of loads and permanent set
Unit stress in kips per "a" on shear area
Elongation in thousandths of an inch in 10"
Av. Efficiency of C1+C2 = 90.0%

Fig. 1.

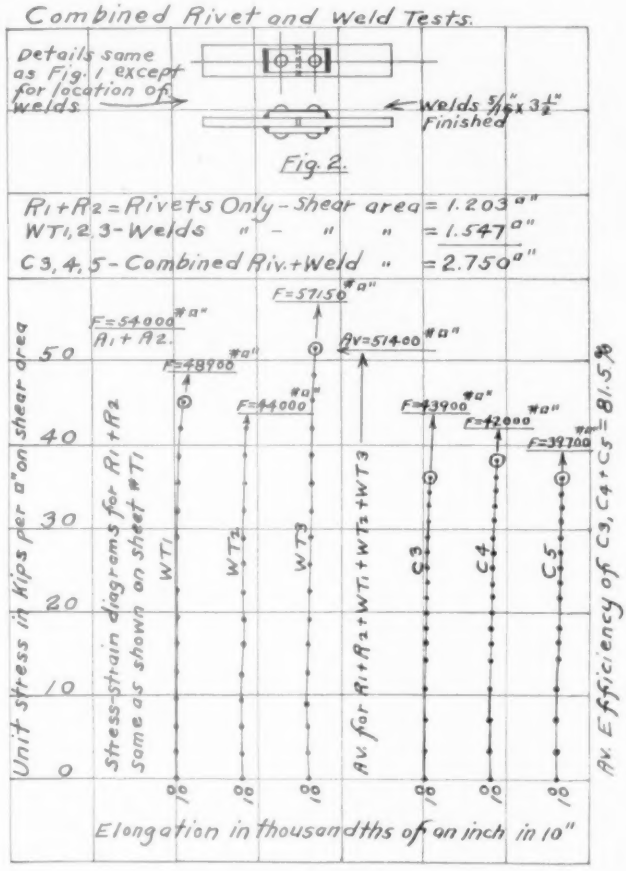

Combined Rivet and Weld Tests.
Details same as Fig. 1 except for location of welds
Welds 5/16" x 3 1/2" Finished
Fig. 2.
R1+R2 = Rivets Only - Shear area = 1.203 "a"
WT1, 2, 3 - Welds " - " " = 1.547 "a"
C3, 4, 5 - Combined Riv.+Weld " = 2.750 "a"
Stress-strain diagrams for R1+R2 Same as shown on sheet #T1
Unit stress in kips per "a" on shear area
Elongation in thousandths of an inch in 10"
Av. Efficiency of C3, C4+C5 = 81.5%

Fig. 2.

†Engineer, McClintic-Marshall Corp., Bethlehem, Pa.

(2) R1 and R2, One rivet only in double shear.

(2) WL1 and WL2, Side fillet welds only.

(2) C1 and C2, Combination of one rivet in double shear, plus side fillet welds.

(3) WT1, WT2, WT3, End fillet weld only.

(3) C3, C4, C5, Combination of one rivet in double shear, plus end fillet weld.

The amount of welding was estimated to have about the same breaking strength, when used alone, as one rivet; based on "heavy-coated" electrodes as used. The welds were machined to the dimensions shown on the sketches.

Test Results—The "efficiency" of a combination joint is taken to be the average breaking strength of that type, divided by the sum of the average breaking strengths for rivets alone and for the corresponding weld alone. This efficiency works out as 90% for the combination of rivet and side weld, and 81.5% for the combination of rivet and end weld.

The stress-strain diagrams for the 12 test specimens are shown on Figures 1 and 2, and the breaking loads are shown thereon.

The stress-strain diagrams for the specimens with rivets only (R1 and R2) are in marked contrast with the rest of the diagrams. This stress strain phenomenon is common in rivet tests and is generally spoken of as "rivet slip." In reality "rivet slip" is a combination of many complex factors. While true "slip" may occur if the rivet does not fill the hole, an examination of test specimens made after failure will disclose the fact that there are other more important factors involved; such as:

1. Bending of the rivet.
2. Spreading of the splice bars, thus adding to the bending of the rivet.
3. Elongation of rivet holes in both the main and splice bars.
4. Compression of the rivet in line with the shearing force.
5. A progressive shearing action across the body of the rivet.
6. True "rivet slip."
7. Friction.

"Rivet settlement" is here suggested as a more appropriate term than "rivet slip."

The stress-strain diagrams for the specimens with welds only (WL1, WL2, WT1, WT2, WT3) are remarkably uniform. The strain, as measured over a 10" gauge length is small. This is to be expected because of the relatively large volume of bar material as compared with that of the weld metal. These specimens all failed through the throat of the weld.

The stress-strain diagrams for the specimens combining both rivets and welds (C1, C2, C3, C4, C5) are of special interest because they constitute the only answer we have, thus far, to the question of combined efficiency.

The noticeable feature of these tests is the apparent support given by the welds to the rivets in preventing "rivet settlement." The influence of this "settlement" is seen to a limited extent in the stress-strain diagrams of C1 and C2; but for C3, C4 C5, this influence is apparently a negligible factor. The explanation is a matter of conjecture, but it is possible that for rivet tests in general, the greatest factor responsible for "rivet settlement" may be the *bending of the rivet;* and that for these "combined rivet and weld" tests, the welds not only prevented the bars from spreading but also (through the action of a transverse couple) carried the greater part of the bending moment. This argument is supported by the fact that the location of the welds shown in Figure 2 is more favorable for relieving the rivets of bending than is the location of the welds shown in Figure 1 (see the stress-strain diagrams in conjunction with this statement.)

These "combination" specimens all failed in the same progressive manner: the weld failed first (through the throat); this was followed by a sudden "drop of the beam" and the final failure of one of the rivets.

Conclusions—While this series of tests is obviously too limited to permit of any detailed conclusions, it nevertheless furnishes a valuable lead for further study.

The high efficiency developed by these "combined" test specimens, especially as to the support given by the welds in preventing "rivet settlement" is of special interest.

It seems reasonable to assume that welded reinforcement can be used to advantage in repairing old riveted structures, provided a liberal factor of safety is allowed. In all such cases the "rivet settlement" may be assumed to have become fixed so that the new welded reinforcement may be expected to "take hold" effectively.

There is a question, however, as to how effectively the strength of a large group of *newly* driven rivets may be augmented by the addition of weld metal. If the thesis that the bending of the rivets is largely responsible for "rivet settlement" is correct, it may be that the behavior of these small test specimens is not necessarily a criterion of what may be expected of a combination of weld metal with a large group of rivets.

While these small test specimens suggest the possibility of "combined riveted and welded connections" for finished design, they also indicate the necessity of further tests on larger joints before drawing final conclusions.

Dr. Adolf Krebs

Dr. Adolf Krebs, well-known consulting engineer and manufacturer, died suddenly at his home, 37 Robinwood Avenue, Jamaica Plain, on Wednesday, June 15th. He was born on Dec. 19, 1864, at Wiesbaden, Germany, the son of Dr. Georg Krebs, an eminent German professor who was a physicist and scientific author of the time.

His education was completed at the University of Berlin, where he obtained the degree of Ph.D., and at the Charlottenburg Polytechnic Institute, where he studied electrical engineering.

He first came to the United States in 1893, as the Siemens representative at the World's Fair in Chicago. He finally settled in this country in 1908 and had been in business here ever since, especially in the oxyacetylene welding industry, in Boston. He was a pioneer in this industry and was prominently known, both in the United States and in Europe, as an inventor, engineer and authority in the oxyacetylene industry. As an inventor and manufacturer, he was responsible for many outstanding developments, notably in oxyacetylene cutting machines, and he was active in this work until his death, being treasurer of the General Welding & Equipment Company of Boston.

Dr. Krebs was the author of "Modern Steam Turbines and Turbine Ships," published in German and French in Brussels in 1904 (3rd edition in 1908), and of "Cutting with Oxygen," published in Boston in 1926.

Dr. Krebs, until his death, was a member of the Executive Committee of the Boston Section of the American Welding Society.

British Structural Welding Practice*

By James Caldwell, M. Inst. C. E., M. I. E. E.

THE British welding engineer in pinning his faith to the heavy coated electrode, maintains that the production of a metallurgically sound weld under practical conditions should not depend entirely on the skill of the operator but as far as possible on the natural function of the electrode during fusion. In other words he considers that a suitable covering should be provided on the electrode to form an active slag that will (1) clean the surface of the parent plates from oxide during welding, (2) protect the weld metal whilst molten from atmospheric gases and therefore prevent oxide and nitride defects from forming in the metal and (3) melt at a low temperature and thereby not be trapped in the weld metal as slag inclusions.

Design

It is certain that success in welding construction depends very largely on the initiative shown by the designer and his ability to break away from existing practice developed essentially for riveting.

Bare wire welded structures of the open truss type, with their general use of the simple lapped joint and rolled steel sections, do not appear to differ very largely in form from riveted structures. On the other hand in Europe there is a more advanced tendency to design welded structures on a monolithic basis, with a general use of butt welded joints, even in main members.

A further characteristic of considerable importance and individual to structures welded with heavy coated electrodes, is the general application of light single run fillet welds. This practice, although of comparatively recent introduction, has been successfully developed to an advanced degree both in Switzerland and Australia. The linear strength of a fillet weld is approximately proportional to the square root of the linear volume of weld metal deposited, so that the economic advantages of the light single run fillet weld are paramount. A further asset is that welding contractional stresses are reduced to a minimum, but what may perhaps be regarded as the most important advantage, is the fact that the soundness of a weld can be judged by expert visual inspection, provided that correctly constituted heavy coated electrodes are applied. Thus the problem of control and inspection is solved in a simple economical and efficient manner.

*Extract from a paper presented before the International Association for Bridge & Structural Engineering, Paris Congress, May, 1932.

Building Regulations and Investigations

One of the most important developments in welded structural steelwork in recent years is the movement of the part of public bodies to draft regulations for its control. Under the usual forms of building regulations, no methods may be used which are not definitely sanctioned with appropriate specifications and provisions for inspection. Therefore the essential first step is to get welding recognized, naturally with safeguards for its proper use. Welding committees have been formed in many parts of the World and their research engineers are submitting welded construction to a more exacting scrutiny in many respects, than has ever been made of riveted construction in the past. It may be ventured that more is now known of the behaviour of welded joints than the behaviour of riveted joints. There have been cases of the failure of riveted joints which have passed the scrutiny of boiler insurance inspectors and hydraulic tests, traceable to the faulty manipulation of hydraulic riveters. Hence it is inaccurate to say that riveted joints can always be guaranteed after inspection by established methods.

In framing regulations one of the most important factors to be considered is the subject of "allowable stresses" or "Factor of Safety". Needless to say most public bodies are inclined to err on the side of safety by specifying low allowable stresses. Whilst this is quite justifiable within reason, it should be borne in mind that the specification of a too high factor of Safety is quite sufficient in itself to prohibit or seriously limit the welding of structural steelwork on economic grounds.

The recent report of the Structural Steel Welding Committee of the American Bureau of Welding states that the average ultimate tensile strength they obtained on butt welds (bare wire) was 22.1 tons per sq. in. on which the proposed allowable working stress of 5.8 tons per sq. in. gives a factor of 3.81 which they assume to be satisfactory as it compares with their normal steelwork factor of 3.⅓.

The generally accepted purpose of a "Factor of Safety" is to keep the load stresses well below the yield point, to allow a margin for indeterminate stresses, and for practical variations in materials and workmanship. Provided suitable specifications are drawn up to control the ability of the operator, electrodes, design and preparation of material, etc., there would appear little reason to anticipate greater variation in the quality and workmanship in welding than riveting. In other words it would appear unreasonable to assume practically the same factor for welding as for riveting or the steel itself.

In Great Britain, for a 28/30 tons per sq. in. steel we have an allowable working stress in tension of 8.0 tons per sq. in. (i.e. a factor of 3.5). It is generally recognized, and has been proved by test, that owing to the unequal distribution of stress induced in tension members by riveted joints, the actual breaking strength is reduced by 20%, so that the effective factor of safety is 2.8 and not 3.5. In compression the allowable working stress is 6.5 tons per sq. in. which when compared with the yield strength of the steel 18.0 tons per sq. in. (the point of failure in compression) shows a factor of safety of 2.77, which is roughly the same as that for tension. These calculations assume that the shearing strength of the rivets bears a definite relation to the tensile strength of the parts joined; often it is assumed that the two are equal. This strength does not come into full play unless

all the rivets are equally good fits in their holes. The 20% reduction is meant to allow for possible departure from the condition it may sometimes by insufficient. Under these circumstances a factor for welding equal to that for the steel, or at the most 4.0 would appear to be ample.

In published results of recent investigations it would appear that much importance is attached to the determination of the static strengths of welded joints. Such values are of secondary importance except for use in design. Factors that deserve more attention are the resistance of welded joints to dynamic stresses, corrosion, solidity and ductility in the weld metal and above all "Consistency under practical conditions". The future of welded steelwork must depend to a very large extent on its consistency under practical working conditions, in other words on its reliability.

The main factors controlling economic and consistent welded production include intelligent design, sound organization and welding procedure, thoroughly trained operators and inspectors and the employment of correct welding equipment and electrodes.

These factors would appear to present much more fruitful fields for investigation and subsequent control than the physical properties of various types of welds which are meaningless unless they forecast with a reasonable degree of accuracy the results that one may expect to obtain in practice.

Strengthening of Steel Structures by Welding

The application of electric welding to the strengthening of steel structures has offered a valuable solution to Railway and Municipal Engineers faced with the problem of coping with increased traffic loads and depreciation due to corrosion. Well over 100 bridges have been strengthened by welding on Australian Railways and quite a considerable amount of important work has been carried out in Great Britain. Similar operations are either in progress or contemplated in India, South Africa and certain of the Crown Colonies.

The main advantages claimed for the application of electric welding to the strengthening of bridges are briefly:

1. In some cases the only alternative to strengthening by welding is complete renewal.

2. Cost is invariably much less than when other methods of reinforcement are employed.

3. Delays to traffic passing over the bridges are avoided or greatly reduced.

4. In most cases underpinning or staging is unnecessary and on principle the existing structure is not weakened or disturbed by the replacement of members and rivets in the initial stages as is often the case with alternative methods.

The strengthening of structures by welding may be divided into three broad classes.

1. The reinforcement of riveting or riveted joints in which the welding and riveting act conjointly in carrying the stresses, as in the strengthening of lattice girder connections or plate girder flange angle and web splice riveting.

2. The reinforcement of existing members by welding on additional plates or sections.

3. The strengthening of girders by increasing their depth or by adding new members such as extra ties struts or cross girders, etc.

Combination of Riveted and Welded Construction

The question is sometimes raised as to how riveting and welding act in conjunction with each other or in other words "What is the strength of a riveted and welded joint?"

It is quite possible for a riveted connection to be reinforced by welding and for the welding to bear the whole of the load and fracture before the riveting comes into play due to the presence of "slip" in the rivets. In the case of an existing bridge, however, it must be borne in mind that the members are already bearing their dead load before the welding is applied and furthermore it would appear safe to assume that the initial slip in the riveted joints has already been taken up owing to the continual variation in the stresses transmitted and the natural vibration of the structure. It has been found that the strength of a combined welded and riveted joint may be estimated as the ultimate strength of the welding plus the yield point strength of the riveting.

In strengthening lattice girder joints it is necessary to ensure that the additional stresses carried by the welding are transmitted across the joint to the member of either side, that is to say, clear of sections that are weakened by the existing rivet holes and this may entail the use of extra gusset plates.

When An Order Is An Order

The general master mechanic of a large steel plant recently addressed a group of Safety men and stressed emphatically the necessity of explicitness in writing orders, emphasizing the necessity for incorporating Safety in the body of the order.

A sample order is quoted below:

"Please repair top 60 foot of stack at No. 3 and No. 4 Blast Furnaces by welding ½"x8" sheet bar vertically every 4 feet and covering same with ¼" thick welded steel stack as per details arranged at conference between Messrs. N. G. and C. Space between brick lining and old shell and between old shell and new shell to be filled with fire clay grout as work proceeds. Inside of all new ¼" plates and all ¼x4 intercostal to be painted shop coat of RED. After erection, one leg of all clips to be burned off as well as couplings used for grouting. Finished stack to be given one coat of RED PRIMER and one coat of SMOKE STACK BLACK. Crown and platforms to be removed. Safety basket to be installed on ladder and this is to be proceeded with at once up to a point of 165 feet of base of stack after which safety basket will be installed as new plates go up from that point. Wooden standard two-rail hand railing to be installed on each section of main scaffold.

It is understood that W. L. will be in charge of this entire job and no man in any department is to go up the stack without permission from him. Under no conditions must men work on the stack when the wind is directly from the north and any man working on the stack, when ordered to do so by L., will come down immediately in case of wind shifting or for any other reason.

This work to be done on five-day basis in the Fabricating Shop and six-day basis on field erection."—*From a News Letter of the National Safety Council.*

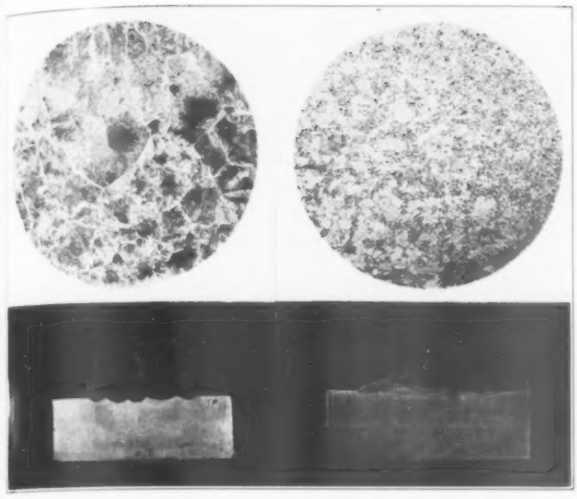


Figure 1. (Upper Left) Photomicrograph of Crystalline Structure of Weld Made with Unshielded Arc.

Figure 2. (Upper Right) Integration of weld metal and parent metal in zone of fusion of weld deposited in shielded arc.

Figure 3. Deposit of weld metal produced by an unshielded arc. Note the extent of slag inclusions which appear as dark spots in the macrograph.

Figure 4. A fine grained structure and absence of blow-holes and slag inclusions show how effectively oxidation and nitration of weld metal has been eliminated by use of completely shielded arc.

Why Some Welds Are Better Than Others

By Wilmer E. Stine†

MY study of why some welds are better than others must concern itself with phenomena within the arc. It is well known that only a stabilized welding current and an arc of proper length manipulated by a trained operator will result in a tough, dense, ductile deposit of high tensile strength; but, for many years, with the very best welding equipment and the most skillful operators, the highest average tensile strengths were not far above 55,000 pounds per square inch. It was not until the innovation of methods which acted to control the chemical reactions within the arc and its surrounding atmosphere that welds of 75,000 pounds per square inch tensile strength and good ductility became possible.

Anyone familiar with electric welding knows that poor welds may be caused by the presence of gas holes in the weld metal. This weld metal consists for the most part of the deposition from the electrode, but the photomicrographs of the crystalline structure of the weld show that the parent metal is mingled with the deposit, in many cases this integration being so great that no line of demarcation is visible. Figures 1 and 2 show integration along the line of fusion. The weld metal in Figure 2 was deposited by a special processed electrode utilizing what is known as the "Shielded Arc" principle which will be discussed later. A macrograph of a weld is shown in Figure 3. This weld contains the undesirable gas holes and slag inclusions. It is obvious that such a deposit will not possess as great physical qualities as a weld which is free from these gas holes which embrittle and weaken the metal. A macrograph of such a weld is shown in Figure 4.

One of the main causes of this porosity is the attraction of steel in its molten state for certain gases. In electric arc welding the temperature of cold steel jumps from around 70 degrees F. to 6000 degrees F. in a fraction of a second. The melting point of steel is somewhat less than 3000 degrees F. At such temperatures certain gases in the ambient atmosphere are rapidly absorbed by the molten steel.

In order to secure welds free from gas holes it is essential that the capacity of the steel for absorbing the various gases at the temperature of solidification shall be much greater than the gases then held in solution. If not the great decrease in the capacity of the steel as it passes through solidification will cause the steel to become saturated and some of the gases will be given up, forming holes in the solid metal.

The capacity of steel for holding gases in solution varies inversely with the carbon content. On the other hand the presence of certain elements in the steel, such as silicon, manganese, aluminum, etc., effect an increase in the capacity of the steel for holding some gases in solution. These elements are often added to the steel at the furnace in order to deoxidize the metal and increase the capacity of the steel for holding gases in solution. Due to the small area exposed to the air the danger of reaching the saturation point of absorption is small. In arc welding, the higher temperatures and greater exposed surface tend to hasten the moment of saturation.

If during the welding, any of the elements, manganese, silicon, aluminum, etc., are oxidized, further reducing the capacity of the steel to hold gases in solution, the formation of gas holes will be further facilitated. Furthermore, the elimination of carbon from the molten metal is increased by the increased temperature. Oxidation of this

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carbon during solidification will probably cause gas holes of carbon monoxide in the weld metal. It is obvious then, that to insure welds free from objectionable gas holes, none of the so-called deoxidizing element be oxidized and deoxidation take place only between the oxygen and the carbon at the higher temperatures. This deoxidation should cease just above the temperature of solidification.

The point we are making is this: Because of chemical phenomena at the great heat of the arc, it is desirable to

Fig. 5. Specimen Weld Bent and Etched Shows Sound Deposit and High Ductility.

maintain a certain proportion between the carbon and the various deoxidizing elements in the steel.

A review of our experimental data shows that welds made under conditions of chemical equilibrium between the oxygen, carbon and the various deoxidizing elements result in welds practically free from gas holes. In commercial arc welding this chemical equilibrium can be approximated or brought about in various ways, as follows:

1. The addition of gaseous, fibrous or metallic material to the arc will often result in approximately the desired equilibrium.

2. The application of a chemical flux to the work to be welded will often obviate the phenomena caused by improper chemical equilibrium.

3. The use of special electrodes, prepared with a knowledge of the metallurgical principles involved, will tend to give the desired results.

4. The specification of a steel manufactured with the deoxidizing elements in such proportion that equilibrium will be insured at a temperature slightly above the melting point. As this discussion is concerned only with ordinary carbon steel, this melting point is about 2800 degrees F.

It is fairly obvious that in most cases oxygen must be excluded from the arc in order to secure welds of high tensile strength and good ductility. In the electronic tornado process of automatic carbon arc welding a fibrous autogenizer is burned in the arc to produce carbon monoxide which excludes free oxygen. The electronic tornado process focuses the stream of a carbon arc on the line of fusion and welds a seam in ¼ inch plate at the rate of 60 feet per hour. The welds made have an ultimate tensile strength of 75,000 lbs. per square inch and high ductility.

A specially prepared electrode is used in the shielded arc process of manual welding. This electrode has a heavy coating which burns in the arc less rapidly than the electrode melts, forming, in effect, a crucible around the arc, shielding it for most of its length. The edges of the coating, burning in the arc, give off carbon monoxide which further protects the molten metal from oxygen. The cooling metal is protected, after solidification, by a layer of slag which is the residue from the burning coating. This slag can easily be removed. Welds made within this shielded arc have a tensile strength of 60,000 to 80,000 lbs. per square inch and ductilities as high as 20 to 30% in 2 inches. On bend tests this ductility runs from 30 to 50%. A typical test specimen of this type is shown in Figure 5.

The formula for specifying steel, the proportional content of which will cause the desired equilibrium in the arc,

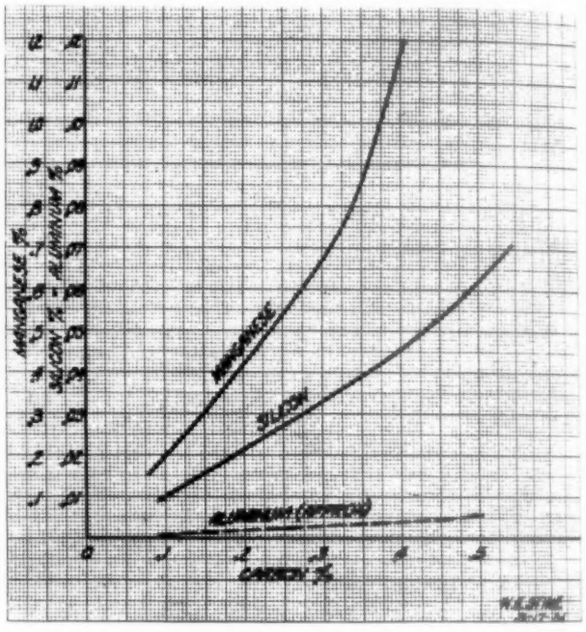


Fig. 6. Equilibrium Curves Prepared to Assist in Selecting Base Metal of Desirable Welding Characteristics.

is shown in Figure 6. These curves were plotted after samples of many types of steel had been analyzed and tested. It has been demonstrated under practical welding conditions that the values indicated on the curves are approximately correct. For example, to ascertain the proper analysis for .25% carbon steel, find .25% on the lower line and follow up vertical line to silicon and manganese curves. The formula will then be:

Carbon	.25%
Manganese	.54%
Silicon	.026%
Aluminum	Not over a trace

It will be seen that research in arc welding has passed beyond the hands of the electrical engineer who first stabilized the welding current, beyond the scope of the welding technician who learned how to weld, into the field of chemistry and metallurgy. For the last three years arc welding processes have been as good as the requirements made upon them, but it is the search for super quality in weld deposits which forwards research. Within a year after the innovation of the shielded arc process, 3000 miles of pipe line had been joined with welds of

(Continued on page 40)

The Job That Couldn't Be Done

The man who wanted to sell a new condenser for three thousand dollars thought the welder would have to cut out the side of the ship to get at the job. The welder fooled him by using live steam for preheating, and fixed the five-foot crack by bronze welding. He got the job on a "cost-plus" basis.

By P. R. Russell

WHILE visiting in Cleveland a few weeks ago I took a walk down to the water front with my old friend, Jim, to look at a job on a towing tug laying along the pier. (Jim and I used to weld together years ago.) Arriving at the tug, we entered the top part of the engine room. Down below there were several men. The floor of this top room was mostly made of grating so we could see the men below and also hear quite distinctly what they were saying. The Captain and Engineer were standing near by listening to the conversation.

Jim was peering down through the grating and listening very closely to what the men below were saying. He pointed below, and there was the job. A condenser had a long break in the side and from where we were it really did look disappointing from a welder's view point. Presently our attention was drawn to the conversation of the men who were standing around the condenser.

The first man was saying, "It is very obvious that welding is out of the question. It would be impossible to weld that shell without removing it from the tug, and to do that it would be necessary to take an acetylene torch and cut the side out of this ship, remove the condenser shell to some shop, pre-heat it, weld it and then what have you? It would be necessary to assemble it, make a test and after it was replaced you would have no assurance that it would hold. Probably you would get out in the lake and it would let go, then where would you be? I am sure you wouldn't want that. I am sure you will do the sensible thing and put in a new condenser. Then your worries will be over."

All during this convercation Jim was squirming around as though the floor was hot. Finally these men came up and left the tug. Just then the Master Mechanic arrived, so we went down into the engine room. The Captain showed us the job. The condenser was about 4 ft. in diameter and about 6 ft. long, and inside of it were several hundred small copper tubes. The crack was approximately 58 inches long and the shell was about 5-16 of an inch thick.

The first thing the Captain said after showing us the job was, "Now you can't build a fire around this shell. If you can't fix it any other way, we had better forget about welding. And another thing, those small tubes are very close to the shell, so you couldn't get them hot or they would be ruined. If we have to remove this shell from this boat we certainly will put in a new one. A representative from the condenser company was just here, and they can furnish a new shell within thirty days. A new condenser would only cost around $3,000.00. This condenser must hold 27 inches of vacuum or it would be useless, so be careful in making your decision. And another thing, we have had about a dozen welders here to look at this job already and none of them will consider welding this shell, so judge accordingly."

Well, they had the old boy almost convinced that it was useless to try to weld the shell, but he started like this, "Say, if you get a new condenser it would be necessary to cut the side out of this boat to get the old one out and the new one in. Wouldn't it?"

The Captain agreed that this was true.

"Now regarding those small tubes. How far are they from the shell?"

Well, the heads were on the condenser, so we could not see from there, but part of the broken shell was sprung out a little. We took a light and a piece of wire and found that they were about three inches away.

"That's all right," Jim said. "That won't hurt them. All right we will weld it providing—"

"Providing what?" the Captain said.

"Providing our price is right. I suppose—"

"But," interrupted the Captain, "no one else would give us a price."

"All right, I'll do it, cost plus, if you will give me all the steam I want."

"What do you need steam for?"

"To pre-heat," replied my friend.

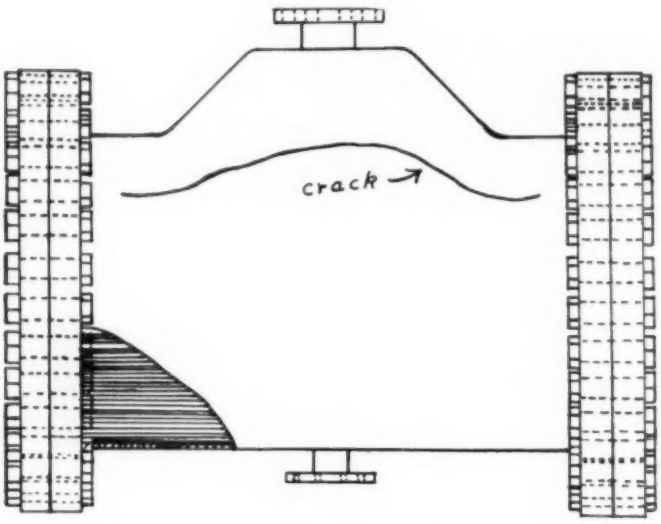
Just then the Master Mechanic spoke up, "I agree with this man. I believe it is possible to get that shell hot enough with steam. What kind of rod do you intend using?"

Jim replied, "Bronze."

The Master Mechanic became quite enthusiastic. I

believe that is the solution," he said. And in the same breath, "How soon can you start and how long will it take? When can we figure on using the boat?"

Well, things began to move. Jim called the shop for two men, electric drill, a couple of ⅜ in. drills, electric grinder, and hammer and chisels. When they arrived, they first drilled holes at both ends of the crack, then drilled holes almost through the shell and just as close together as possible. After this they ground the small



Sketch Shows Nature of 52-Inch Crack in Condenser.

section remaining between the holes. Before starting to drill, a couple of screw jacks were placed on the parts of the shell that had sprung out. The other end of the jacks were placed against the vertical engine. And by the way, this condenser was sitting close to this engine; in fact, so close that it made work very difficult. By this time evening had arrived, so Jim told the Captain to turn the exhaust steam into the condenser until about 4 A. M. the next morning, and then turn on the live steam and we would be there ready to start about 7:30.

Next morning the boys had gas, oxygen, bronze and flux, and welding equipment loaded into the truck ready to go. Away we went to the boat; arriving there we found everything ready. The condenser was very hot, and boy what a place! You couldn't see your hand in front of you, that old tug was so full of steam. It really was very difficult to breathe, but soon everything was ready, so Jim started the actual welding and it took about two hours. It was just about as difficult a place to weld as I ever saw, due to the vertical engine being so close to the condenser.

In the beginning we thought the steam in the room was terrible, but when you got that steam full of bronze fumes you have something that is bad. Some of the boys couldn't stand it and had to get out. Those that did stay soon began to complain of chills and by the time we were through everybody was more or less affected. Our clothing was soaking wet. The thing that helped us the most was hot coffee, and that steward sure knew how to make it. About one hour after completing the welding, the live steam was turned off, and about two hours later the shell was filled with boiling hot water. This gave us a first test and we only had two small pin holes. These they calked, and left the job for the day.

Jim said that the best way to cool the job slowly was to just leave the water in it and in the morning the entire thing would be cold, and sure enough, it was cold and also tight. I couldn't stay to see the vacuum test, but Jim agreed to write and let me know the result. I have just received his letter this week, and he said that the Captain was very much pleased, as the condenser again held 27 inches of vacuum.

Why Some Welds Are Better Than Others

(Continued from page 38)

tensile strength averaging over 74,000 pounds per square inch. The improved quality of welds made possible by advanced knowledge of phenomena within the arc has increased welding speeds 300 to 400 per cent, bringing not only greater strength but greater economy to the manufacturer.

Why are some welds better than others? In the field, better welds are brought about by the application of arc welding processes based upon scientific study, experiment and research.

Program Nearly Ready for Buffalo Meeting

The advance report of the progress made by the Meeting & Papers Committee of the American Welding Society shows that they have been very successful in arranging for an unusually fine collection of papers on popular welding subjects for the Fall Meeting, which is to be held in Buffalo during the week of October 3rd. Headquarters of the Society will be in the Statler Hotel, and the morning technical sessions will be held there. The afternoon sessions will be held at the 174th Armory, where the National Metal Exposition will be located. One technical session will cover several phases of the fabrication of heavy machine parts from rolled steel by cutting and welding. Another session will deal entirely with non-ferrous metals, including Duralumin, high nickel alloys and lead. A third group of papers to be presented at the same session will consist of reports of some of the important research work on the fundamentals of welding which is being carried on by the engineering departments of some of our largest universities and industrial research laboratories. The subject of another special session is that of merchandizing. This is a new topic and is of real importance at this time. An entire afternoon will be devoted to discussions of qualification tests and it is expected that this will be productive of many valuable suggestions for preparing operators to do better work. Other sessions cover quite a range of miscellaneous subjects, including structural welding, repair welding, resistance welding, metal spraying, pressure vessel welding and automatic welding.

Complete final details regarding the program will be available next month, together with lists and descriptions of the welding exhibits in the Exposition. Many of the exhibitors other than manufacturers of welding products will have interesting things to offer to the welding department, and there are several exhibits planned, of welding interest which have not appeared at any previous shows.

Welding Bridges in Australia

In view of the widespread success of welding in bridge construction and repair throughout Australia, this report of a job on a 450-foot bridge, with details of design, procedure, inspection and test results will be useful to the welding contractor and the bridge engineer.

GREAT interest was shown in the paper abstracted below, which was read in Sydney, Australia, recently by Mr. G. R. Cockburn, A. M. I. E. (Aust.), an engineer of the Railway Department. The paper was published in the Journal of the Institution of Engineers, Australia, Vol. 4, No. 4.

Description of Bridge

The paper describes in detail the strengthening of the steel Pratt truss railway bridge over the Hunter River at Singleton. The bridge is of 5 spans, each 90 feet long, and carries a single track of 80 lb. rails, placed on timber transoms bolted to the top chords of the main trusses. Built in 1902, the bridge carried increasingly heavy traffic until 1926, when it was decided to strengthen the structure to carry Cooper's E40 loading plus 80% impact. The cost of the work was approximately $50,000 and the time taken 15 months, no delays to traffic being permitted.

Design of Welded Additions

General Principles—The safe working stresses were those which have since been adopted for the Fusion Welding Code of the American Welding Society.

The fillet welds ranged from ¼ inch to 1¼ inch, all welds ⅜ inch and larger being specified as multiple-layer, the number and arrangement of layers being shown.

The welding at the diagonal gussets was designed to take the whole stress, entirely relieving the existing rivets.

Plates and flats were used in preference to structural sections in order to avoid risk of distorting the existing members.

Details of the strengthening and of the various welds are shown in Fig. 1.

Bottom Chords—A flange plate 15 inch by ⅝ inch was added to the four 4″x4″x⅝″ angles, being welded to the bottoms of the vertical legs of the lower angles. The 9/16 inch fillet welds were deposited downwards in three layers. Three butt joints necessary in the plates were reinforced with straps.

Top Chords—The transoms were packed up and a 16″x1″ flange plate slipped into position on top of the existing channels, where it was welded as traffic permitted.

Diagonals, Verticals and Bracing

Flats and plates were welded to the existing members where necessary. (Fig. 1.) In some cases a plate was welded in between two existing flats to form a H section.

Qualification of Welders

The gang consisted of eleven men, a foreman, four welders, four assistants, one bridge hand and one flagman.

The welders were selected from a large shop force, but it was found that a man's record under sheltered shop conditions was no measure of his usefulness on bridge work.

The specimens welded by the men for qualification purposes are shown in Fig. 2, and were clamped to a diagonal of the bridge at a slope of 45 deg. as shown. In this position two of the fillet welds had to be made in a semi-overhead direction. The testing of the welders was repeated at intervals during the progress of the work. After the specimens had been broken in tension in the laboratory they were returned to the bridge and each discussed with the men concerned.

Procedure

Bottom Chords—On each truss of each span, the flange plates were clamped to the bottom chord, and four welders commenced at the centre line, two on either side working in opposite directions for one panel length and depositing one layer of metal. Each of the required three layers was completed in a similar manner. At each panel point the diagonal gussets were welded before welding of the flange plates proceeded.

Top Chords—As the transoms had to be temporarily removed for welding, a different procedure was followed. Commencing at the centre of the span, four welders worked in the same direction, two being on each truss. Three layers were deposited during the first passage of the welders, and the two final layers during the second passage.

Verticals at Abutment-Ends of Trusses—The difficulty experienced in welding these verticals to the gussets pointed to the necessity of designers allowing proper clearances between piers and abutment-ends, but proved that welding could be successful in very confined spaces.

Cleaning—Each span was carefully chipped and scraped where welding was to be done. When covered electrodes were being used the slag was completely removed from each layer before the next was deposited.

Field Records

A log book was kept of all operations, including each welder's time and his particular portions of the work, and cost cards from each welder showed a weekly record of the amount done.

A weekly record was prepared showing diagrammatically the progress of the welding, and variations in camber and length of members.

As welding of the bottom chord progressed the camber of each truss increased, due to contraction in the bottom chord, but in welding the top chord this action was reversed, until the final camber was slightly less than the original. These records proved to be a valuable safeguard against undue distortion.

Current Supply

Four single operator 200 amp. motor-generator sets were used on the bridge, the power supply being tapped from a 30,000 volt transmission line through a temporary substation.

For later works on which power was not available, the Department designed and built a Power Van, housing a 60 KW alternator, driven by a 100 bhp. crude oil engine, an air compressor, and the necessary fuel and water tanks. A folding radiator was fitted on the roof.

Tests of Finished Structure

Table 1 shows the deflections of the trusses under stationary loading, before and after strengthening. The maximum stiffening occurred in the span welded entirely with bare wire.

When the locomotives crossed the bridge at speeds up to 50 m.p.h., the tabulated deflections were exceeded by about 0.1 inch.

Stresses in various members under dynamic load were obtained by the use of a Cambridge Stress Recorder, and were found to be less than the stresses calculated by the usual methods.

Table 1

Comparison of Deflections due to Stationary Loading. Two 53 Class Locomotives Coupled.

When Tested	No. 1	No. 2	No. 3	No. 4	No. 5
Before Strengthening	0.72	0.82	0.77	0.75	0.73
After Strengthening	0.51	0.52	0.49	0.48	.....

Note: Total weight of two locomotives, 560,000 lb. Span No. 2 welded entirely with bare wire.

Comparison of Covered and Bare Wire Electrodes

Span No. 2, welded entirely with bare wire, was completed in eleven weeks, while Span No. 4, welded with coated electrodes except on the compression members, which were welded with bare wire, required a net period of sixteen weeks. The extra time required for welding with coated electrodes is expended in puddling out slag and in chipping each run.

Tests on specimens of deposited weld metal prepared in the field gave the following results:

Electrode	Yield Point Lbs./sq. in.	Ultimate Str. Lbs./sq. in.	Elongation Per cent.
Covered	43,500	54,300	13.5
Bare	43,300	54,500	12.0

Chemical Analyses were made to determine the compositions of the electrodes and of the deposited metal.

Specimens welded with coated electrodes and with bare wire were placed in a tidal river so that they were exposed to sea water and to the wind as the tide rose and fell. After two years all specimens and weld metals showed equal amounts of corrosion.

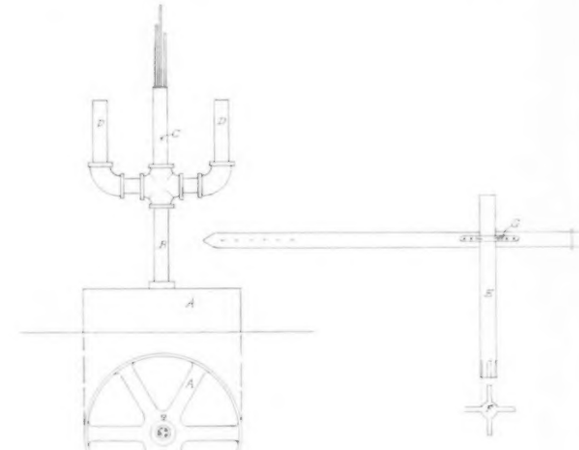
Analyses of stresses should determine the quality of the electrodes to be used for a particular joint, the superior ductility of the best coated electrode weld metal being required in joints subjected to severe bending or buckling, while cheaper electrodes would be found satisfactory on members subjected to direct compression or tension.

Strengthening of Other Bridges

The paper makes brief reference to subsequent strengthening operations on seven other railway bridges in New South Wales, including the famous Hawkesbury River Bridge, erected by the Union Bridge Company and other American contractors over forty years ago. The general principles followed were the same as those outlined above.

Shop Holders for Welding Rods Easily Made of Old Materials

Shown at the left, in both plan view and elevation, is a holder for welding rods which may be quite easily moved from place to place with a rolling motion, by tipping it somewhat on its rim. The welder can shift its position with one hand. Any castoff iron pulley will do for the base. If the hub interferes, cut it back on one side to allow it to set level. A piece of pipe "B" of suitable size is made fast to the pulley either by the setscrew or by welding it, and fittings are attached to it as shown. Fit-



Handy Ways to Take Care of Rods and Electrodes.

tings may be arranged to furnish several upright pieces of pipe if desired to hold many different kinds of rods for variety welding. The central stem may be filled up to the point "C" with cement. If one is welding one kind of work continually, he may prefer to have only the one upright piece of pipe.

On the right, we have a holder for rods which the maintenance and job welder will find convenient to wear right on his belt as shown, as well as workers who must climb to weld on large items. The holder proper is made fast to the belt in such a position as will throw it just over or behind the hip. Iron pipe is too heavy to serve this purpose well; a very small size of downspouting is better, such as is commonly used for porch work. One end of the hollow cylinder is closed up with a piece of sheet metal of the shape shown at "F." This is applied and soldered to "E" as shown, and the sheet metal clip by means of which it is attached to the leather belt as shown at "G," is also tightly soldered into place. All that then remains is to rivet the piece "G" to the leather belt. This can be done with either copper harness rivets or tubular rivets.

I. A. A. Will Meet In Philadelphia

It has been decided to hold the 33rd Annual Convention of the International Acetylene Association in the Penn Athletic Club, Philadelphia, Pa., on November 16, 17 and 18, of this year. The Program Committee has already received assurances of splendid co-operation from the American Welding Society and several other engineering organizations in Philadelphia for the arrangement and promotion of the convention; so it is expected that new attendance records will be set. The facilities of the Penn Athletic Club are said to be the best that have ever been available to the convention, being fully equipped with all the conveniences necessary for the technical sessions and with ample capacity. Accommodations for guests are available at very low rates, and the extension of club privileges to members and guests assures unusual comfort for those who attend the 1932 convention. It is probable that a night session will be held somewhat similar in character to the session which proved a record breaking attendance at the 1931 convention, and in addition to this there will probably be five technical sessions with papers covering important phases of oxy-acetylene welding and cutting.

International Institute of Steel Construction

An international Institute of Steel Construction has been organized to which American participation has been invited. It is proposed that executive offices under the direction of E. A. Van Genderen Stort, Adviscerend Ingenieur, shall be established in The Hague. This step was taken at a conference held last May in Paris, a report on which has just been received by the American Institute of Steel Construction.

During the last 11 years offices have been established in most steel-producing and steel-consuming countries, with the purpose to encourage the use of steel upon a more rational and economical basis. This was done by pointing out the excellent features of this material as well as at the advantages its use offers. In America the foundation of the American Institute of Steel Construction in 1921 gave an impetus to this movement.

Hoover Dam Outlet Pipes

Further details of the contract awarded by the United States Government, Department of the Interior, Bureau of Reclamation, to the Babcock & Wilcox Company, 85 Liberty Street, New York, for the fabrication and installation of the welded plate-steel outlet pipes for the hydraulic power and flood control tunnels at Hoover Dam are now available. The contract involves such unusual features as the fabrication of the largest diameter pipes ever constructed, from plates about three inches thick, and the erection of a plant, built solely for the purpose, on the Federal Reservation near the dam. The total length of the pipes to be constructed exceeds 12,000 feet with the variations in diameter from 8½ to 30 feet.

A complete fabricating plant will be built at the site of the work on account of the large diameter of the pipe sections, which cannot be transported over any existing railroad lines. Each section of 30-foot pipe will require six steel plates of the largest size that can be rolled with existing steel mill equipment. Each plate, weighing about twenty-five tons, will measure approximately 12x 35 feet, and two such plates are all that can be shipped from the steel mill to the fabricating plant on one railroad car. Three of these plates, after being formed and welded together, will make one piece of 30-foot diameter pipe about 12 feet long, and two pieces joined together in the fabricating shop will constitute one section weighing about 150 tons, exceeding the weight of many railroad locomotives.

From the field plant, the sections of pipe must be transported to the rim of the canyon on carriages comparable in capacity with those used for moving the heaviest artillery or coast defense guns. From this point each section will be transported across the canyon and lowered 1,000 feet, by a cable way, to the entrance to the several tunnels. This cable way will have more than double the capacity of any heretofore used for such purposes and will have a span 1,400 feet long and will be supported on steel towers 150 feet high.

All sections of pipe will be tested in various ways, one of the tests being searching X-ray examinations of the welded seams. While the Babcock & Wilcox Company has for some time employed X-ray apparatus for the purpose of determining the quality of welded joints, it is interesting to note that the quantity of X-ray film which will be used for this work will exceed the total of all X-ray films produced to date for industrial purposes.

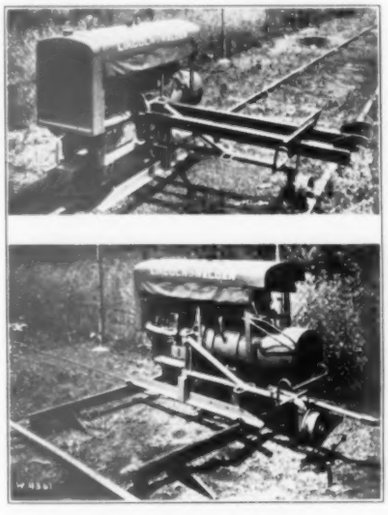
X-Ray Technique Given for 4-Inch Steel

In the July issue of the *General Electric Review*, R. E. Hiller, of the works laboratory of Babcock & Wilcox Company, Barberton, Ohio, gives a complete illustrated discussion of a technique for the examination of steel of 4 in. thickness by the X-ray. This article is one which is found to be of interest to those who are using the X-Ray method of inspection on heavy plate because of the detailed description of the apparatus used and the care used in presenting all of the important details of the procedure used in making the inspections.

Lincoln Track Welder

Quick removal from the track is the outstanding advantage of a new Track Welder for building up worn railends and repairing frogs, crossings and switches, announced by The Lincoln Electric Company, Cleveland, Ohio. One man, in one minute, can quickly remove the unit from the track and place it in position for use, according to the manufacturer. Because of this portability the operating crew is kept at a minimum with resulting economies.

In general, the unit consists of a welder generator and a grinder generator, close coupled to a gasoline engine, and mounted on roller bearing equipped truck for movement along the track. Total weight is only 1450 pounds. Removal from the track is quickly accomplished by removing the take-off rails from the carriage and placing them in position opposite the take-off rolls, where they fit over the flange of the track with cross supports resting on the ties. Thus the machine is adequately supported by cantilever action and is not dependent on the ground level.



Lincoln Portable Track Welder on the rails. One minute later the welder is off the track ready for service.

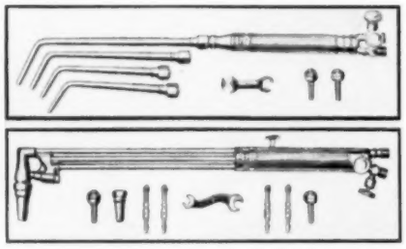
After the take-off rails are in position, the handle is lifted and the unit pushed to the end of the rails. The third wheel is then swung out of the way, leaving a clearance of not less than 36" to the near rail. Take-off rails can be used on 5", 6" or 7" track by a simple adjustment. Three point support when the machine is off the tracks self adjusts the machine to any unevenness in the take-off rails due to variation in the tracks.

The welder is of standard Lincoln construction with a rating of 200 amperes. Welding capacity is from 50-250 amperes. Either bare or coated electrodes may be used. Dual control permits large current adjustment by means of a system of plugs and receptacles and fine adjustment by means of a rheostat scale.

Due to the portability and ease of removal from the track, it is unnecessary to use extra long leads. Leads of 125 feet allowing a welding range of 250 feet are sufficient since it is a simple matter to place the welder back on the track and move it to a new location. The use of shorter cables reduces the weight of the unit, increases the operator's efficiency and cuts power losses.

New Torchweld Cutting and Welding Torches

Two new models of Torchweld torches have recently been introduced by the Torchweld Equipment Company, Chicago, and are illustrated and described in a special bulletin which has just been published. The new welding torch is called the 24 NF. This model is adapted to pipe welding and general production welding. The tips are of swedged copper. One size mixer serves



Torchweld 24 NF Welding Torch and 27 MC Cutting Torch.

for all tips. Tips numbered 1 to 4 are 6 in. in length; 5 to 8—8 in. in length; 10 to 12—12 in. in length. This model embodies the regular safety non-flash features of the Torchweld design and operates on equal pressures corresponding with the size of the tip. It has all permanently brazed joints and its seat is protected against wear by an ingenious design of the block-nut connection. It is priced at $25.00 complete with four tips.

The new cutting torch is catalogued as 27 MC. This model was produced to meet the demand for a light-weight, durable cutting torch. It weighs 30 ounces and has nickel tubes instead of brass tubes, and all permanently brazed joints. Under test, the manufacturers state that it has shown low oxygen consumption and clean cuts with a minimum of slag. They state further that the simplicity of its construction enables the user to keep it in good condition at minimum cost. The high pressure valve is accessible from the back and there is no necessity for dismantling to make any repairs. This torch also embodies the Torchweld safety non-flash features and it is adaptable for both general and production cutting. The price is $40.00 complete with four tips and nozzles and nozzle sleeve.

Automotive Welding Outfit

A new welding outfit known as the Oxweld Automotive Welding Outfit has been announced by The Linde Air Products Company, 30 East 42nd Street, New York, N. Y. Although this outfit is intended primarily for the auto repair shop, its adaptability to a wide range of work also makes it appropriate for many other repair jobs. The Oxweld Type W-17 welding torch which is offered in this outfit with three welding heads is a low-pressure injector type. The extent of its utility can be increased as additional facilities are required by the shop, for accessories to widen its range are available. The Type CW-17 Cutting Attachment attaches directly to the handle in the same manner as a welding head and provides a means of cutting steel up to 3 in. in thickness. The cutting attachment is so compact that it may be carried in the operator's pocket. A special assortment of supplies to suit the needs of the automotive repair shop is also being offered.

Flash Trimmer Has 72-Inch Stroke

A new flash trimming machine has recently been placed on the market by Morton Mfg. Co., Muskegon Heights, Mich., for use in removing the flash or upset produced in butt welding sheets or plates. It is being used very successfully in salvaging scrap and trimming of new sheets of various widths up to 72 inches long.

This machine is built on the Morton Draw-Cut principle and the draw-out features are claimed to assure accuracy and the high production. It uses two rams which trim both sides of the sheet in one operation. The cutting cycle is completed on the inward or draw-out stroke. The clamping of the work is accomplished by air cylinders which automatically compensates for any variation in the thicknes of the sheet.

The rams carry multiple cutting tools which are quickly adjustable for height, also strengthening rollers which precede the cutting tools and straighten any uneven surfaces that may be in the sheets or plates.

This machine can be furnished with any length of stroke to suit requirements. It has a working stroke of 72 inches with a distance between the center of rams and floor of approximately 42 inches. It requires an operating floor space of approximately 5 ft. by 18 ft.

Cutting Attachment for Welding Torch

Smith Welding Equipment Corporation, Minneapolis, Minn., has placed upon the market a new cutting as-

New Smith Cutting Attachment

sembly, or attachment, for a welding torch. In designing this cutting assembly the engineering department eliminated levers for the cutting oxygen, adjustable unions to change the position of the assembly in the handle, etc., and substituted simple valves for these features. The cutting oxygen valve is a triple thread, screw valve with knurled thumb wheel as shown, so arranged that it can be opened and closed with the thumb. The valve forging has been reduced to a simple design, the cutting tip automatically evens up the flames. The new assembly has been approved by the Underwriters' Laboratories.

New British House Organ

The Suffolk Iron Foundry, Ltd., Stowmarket, England, who are manufacturers of a welding rod marketed under the trade name of "Sifbronze" have recently started the publication of a magazine which is called *Siftips*. The first issue was printed in July and the manufacturers state that it is their intention to bring it out two or three times each year. In the initial number there are a number of excellent articles on important applications of bronze welding.

Taylor Bulletin Illustrates Welding Fittings

An eight-page bulletin just issued by Taylor Forge & Pipe Works, of Chicago, shows applications and typical installations of the Taylor line of forged fittings for welding including elbows, tees, caps and reducing nipples. These are shown applied to building piping, gasoline plant piping and gas pipe line work. Some space is also devoted to illustrations of Taylor spiral pressure welded pipe which is made from steel, copper alloy or Toncan iron.

Air Reduction Booklet Describes Aircowelding

The Air Reduction Sales Company, 60 East 42nd Street, New York, have prepared a 16-page booklet attractively printed in two colors to tell the story of the new welding technique which they developed and to which they have given the name "Aircowelding." This has been developed especially for pipe line work. While it is announced as a new process, it is pointed out that the process has been successfully used on many miles of actual pipe line construction jobs.

The advantages claimed for the process are that it makes puddling unnecessary. For a given size of vee it makes possible a small weld. It permits the use of vees with a smaller angle leading to further reduction. It saves from 30 to 50 per cent in welding time with corresponding reductions in labor, gas and welding rod. It is just as effective on position welds as on rolling welds. It produces strong, sound welds and the procedure can be learned in a short time by the average field welder.

Briefly, the Aircoweld technique consists in heating the vee surface of the pipe ends only to a sweating condition without melting down the sides. A special welding rod called the Aircoweld No. 3 rod is used and the flame adjusted with a slight excess of acetylene. The torch is held so that the

How a locomotive cylinder was repair-welded with TOBIN BRONZE at a saving of $1200

1

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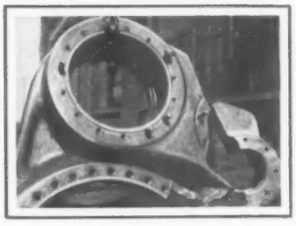
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1. The cylinder seemed damaged beyond repair.
2. One piece of metal was completely broken off . . .
3. . . . as was another even heavier piece. However, repair-welding with Tobin Bronze was decided upon.
4. A preheating furnace was set up around the reassembled cylinder parts, although in ordinary work preheating with Tobin Bronze is unnecessary.
5. The welding almost completed . . . without having removed the cylinder from the engine.
6. The finished weld, viewed from above and in front . . .
7. . . . and from the side; as strong as the casting itself.
8. The entire repair saved $1200 and weeks of costly delay.

There is a suitable Anaconda Filler Rod for every bronze-welding purpose. Principal Anaconda Welding Rods, with their melting points, are listed below:

for oxy-acetylene welding

Tobin Bronze*	1625° F
Manganese Bronze	1598° F
Brazing Metal	1634° F
Electrolytic Copper	1981° F
Silicon Copper	1981° F
Phosphor Bronze	1922° F
Everdur*	1866° F

for arc welding

Silicon Copper	1981° F
Phosphor Bronze	1922° F
Everdur*	1866° F

*Reg. U. S. Pat. Off.

The unvarying high quality of Anaconda Copper Alloy Rods is due to the technical experience gained in developing a complete line for low temperature welding—gas and electric. Anaconda Rods are available through leading distributors . . . usually shipped in bulk, but also obtainable in clearly labeled ten-pound packages. For complete information, ask for Publication B-13.

THE AMERICAN BRASS COMPANY

General Offices: Waterbury, Connecticut

Offices and Agencies in Principal Cities

In Canada: ANACONDA AMERICAN BRASS LTD., NEW TORONTO, ONT.

ANACONDA
from mine to consumer

ANACONDA WELDING RODS

flame is directed back at the completed portion of the weld. There is obviously a saving in time and materials due to the fact that the sides of the joint are not melted down and that the bevel does not have to be as wide as in the case of the ordinary ripple weld. Extensive laboratory tests have been made to show the dependability of the welds produced by this technique. These tests include tensile tests, bend tests and hydrostatic tests of welded bonds and fatigue tests. In addition to these laboratory experiments, there have been several successful field operations, and field tests made on these jobs have been thoroughly satisfactory.

New Booklet On Everdur

An eight-page bulletin has recently been prepared by the American Brass Company, Waterbury, Conn., featuring Everdur metal as a high strength, weldable metal for rustproof tanks and pressure vessels. The center spread in this bulletin illustrates Everdur tanks in capacities from one gallon to 20,000 gallons. Sixteen well-known automatic water heaters equipped with Everdur tank units are also shown. The booklet gives complete information regarding the physical properties of Everdur and tables for calculating the capacities of tanks of various dimensions.

New Hobart Literature

Hobart Brothers, Troy, Ohio, are sending out some attractive folders advertising the Hobart arc welders. One of these features strongly the use of these machines by United States Government departments, at the same time illustrating the class of work done for industrial plants by a number of users. A second folder illustrates the gas engine driven machine and gives a list of the important features together with views of half a dozen different types of applications. In this folder attention is particularly called to the possibility of using current from the generator for the operation of drills, grinders, hammers, lights and miscellaneous electric tools.

Elkon Booklet Describes Good Water Cooling

A bulletin entitled "Mushrooms Are All 'Toadstools' in Welding," has just been published by P. R. Mallory & Co., Inc., Elkon Division, Indianapolis, Ind. The title is explained by the statement that electrodes which mushroom are "poison to production." The text of the bulletin discusses the problems of proper water cooling of spot welding electrodes for the purpose of minimizing mushrooming, saving time and increasing the uniformity of the welds. It contains diagrams of various types of water cooling systems for electrode tips as well as descriptions of Elkonite and Elkaloy for use with these tips. The back cover is devoted to illustrations and specifications of stock types of replaceable tips in Elkonite and Elkaloy. This is accompanied by a complete price list of tips made with these two materials in various designs including prices on water cooled electrode holders. This is all pertinent and useful information for those who use spot welding machines as it brings together a splendid collection of material bearing on the important operating conditions.

Goodrich Condensed Catalog of Industrial Rubber Goods

Containing engineering information and data never before published, a new, condensed catalog giving a simplified, comprehensive line-up of principal industrial rubber goods has just been issued by The B. F. Goodrich Rubber Company, Akron, Ohio. It is titled "Engineering Data, Industrial Rubber Goods" and is available to those who request it.

Among the condensed engineering data, is Table No. 6, page 11, a practical means whereby an engineer may estimate the pressure required to deliver a desired amount of liquid through hose of various diameters. Two grades of welding hose are listed on page 17, one of them being the recently announced heat resisting hose.

New Murex Booklet

Numerous applications of inorganic flux coated welding electrodes are described in a new book just published by the Metal & Thermit Corporation, 120 Broadway, New York, N. Y., which earlier this year introduced Murex heavy mineral coated electrodes. The new booklet describes the welding of mild steel and boiler plate, stainless steel alloys, manganese steel, high carbon steel and stainless iron. The building up of railway rail ends, special manganese track work as well as the repair of castings and heavy parts is also covered.

Torchweld Appoints Jensen Sales Manager

Announcement has been received that J. L. Jensen has been appointed manager of sales of the Torchweld Equipment Company, Chicago, Ill., manufacturers of the Torchweld line of welding and cutting apparatus. Mr. Jensen has been connected with the Torchweld sales force in Chicago for many years and has traveled extensively among the trade in the central west, so he brings to his new position a thorough knowledge of the line and also a wide acquaintance in the trade, and an intimate knowledge of the requirements of the industry.

Westinghouse to Erect Large Building

A new all welded 60,000 sq. ft. warehouse will be erected by the Westinghouse Electric and Manufacturing Company at their Mansfield, Ohio, works for storing electric ranges and refrigerators, according to J. S. Tritle, Vice President and General Manager. Work is to start in July and the four-stories-high building will be completed by November 1. The cost is estimated at $150,000.

Built of brick and steel, the large building will be thoroughly modern and will contain three crane aisles, each 65 feet wide, in which stock can be piled 40 feet high. The roof trusses and all of the steel structure will be arc welded, no riveting being used. The trusses will be of new light weight design, created by Westinghouse engineers. This truss design makes for lighter weight construction with no sacrifice of strength, and minimum fabricating costs.

Gas Equipment Company Opens in St. Louis

The Gas Equipment Company has been established at 3137 Olive Street, St. Louis, Mo., by R. C. Gutke who, for ten years was connected with the sales force of the Torchweld Equipment Company in the Chicago district. The new company will act as a sales office representing the Torchweld line of oxy-acetylene welding and cutting apparatus in the state of Missouri (excepting the Kansas City district), in southern Illinois, northern Arkansas and northeastern Oklahoma.

Adcox Schools Get Approved Rating

The Adcox Schools, Inc., of Portland, Oregon, have just been awarded by the aeronautics branch of the United States department of commerce, the approved shop rating, and this institution has become the third school to be so rated on the Pacific Coast and first in Oregon.

Daniel "Danny" Grecco, the first man to receive an air-craft mechanic's license in Oregon, with 16 years of flying and repairing of air planes to his credit, is the foreman of the shop.

John Goodin is instructor in welding and also holds an air-craft license and is a registered engineer.

The Adcox Schools is the oldest trade school in operation in the Pacific Northwest and has been in operation continuously for the last twenty-two years. Some twenty-five students are now enrolled in the mechanical and welding department.

New Hollup Appointments

The Hollup Corporation, Chicago, Ill., has announced the appointment of O. L. Howland as Eastern Sales Manager for the Hollup Corporation, with headquarters at 30 Church Street, New York City. Mr. Howland was formerly associated with the Koro Corporation of Chicago for a number of years, and previous to that connection, has had considerable experience in the welding industry both on the operating end and in connection with sales and service work from manufacturers of arc welding equipment and electrodes.

Announcement has also been made of the appointment of O. P. Hanchette as representative of the Hollup Corporation at 1615 E. 82nd Street, Cleveland, Ohio.

The offices, show rooms and stock rooms of The Olympic Glove Company, formerly located at 611 Broadway, New York City, are now located at 95 Madison Avenue, at 29th St.

NEWS OF THE INDUSTRY

The American Welding & Boiler Works, featuring general welding work of all kinds, which recently organized and opened for business at 4115 Alameda Boulevard, Los Angeles, California, is moving to a new location at 1580 E. Slauson Avenue, in that city. C. Ward is owner and manager of the new concern, which, in addition to general acetylene and electric welding work, will also handle tank building and boiler work. Charles T. Watkins, former manager of the United Tank & Welding Works, in Los Angeles, is now associated with Mr. Ward in his new enterprise.

The Flemming Forge & Welding Works, of Long Beach, California, is now employing welding extensively in the manufacture of Stevedore trucks which are being used extensively in the handling of cargo at the loading wharfs in Wilmington and San Pedro (better known as Los Angeles Harbor). A 200-amp. Hobart electric welding machine was recently installed by Mr. Flemming, and among other recent changes in the plant was the building of a new office.

Don Leach, Tulsa, Oklahoma, representative for the Chicago Bridge & Iron Works, left recently on a vacation trip. His plans are to spend most of his vacation time in Iowa and Indiana.

E. W. Yount, of Yount's Welding Shop at 608 Menor Street in Winfield, Kansas, reports the recent purchase of a new 300-amp. Hobart electric generator which he has mounted on a portable chassis and hooked up with a spare gas engine. Mr. Yount is an old-timer in the welding game in Southern Kansas, and is equipped to handle any and all kinds of shop and field welding by either acetylene or electric arc process. He also does considerable boiler and tank work in that territory.

Revere Copper and Brass, Incorporated, has opened a sales office in San Francisco at 1615 Russ Building. R. H. Binns, Jr., Pacific Coast Manager in charge of this office was formerly assistant sales manager of the Rome Division of Revere and before that engaged in the metal distributing business. The opening of this office gives Revere customers on the Pacific Coast and in other far-Western states closer direct contact with the company.

At a meeting of the Australian Welding Institute, held in Melbourne June 28, E. J. Raymond lectured on "Gas Welding of Anti-Corrosive and Heat Resisting Steels." The lecture was illustrated by lantern slides and exhibits of welded specimens.

Machinery and Welder Corporation, formerly located at 2009 N. Circero Avenue, Chicago, Ill., has recently changed its address to 316 N. Sheldon Street, Chicago, Ill. The concern handles the General Electric line of arc welding equipment, electrodes and accessories.

A. M. Castle & Co., Chicago, Ill., has been appointed the distributor of the Babcock and Wilcox Tube Company's products in the Chicago and Pacific Coast territories.

The business and equipment of W. P. Paul Co., Philadelphia, Pa., has been purchased by Harrisburg Pipe and Pipe Bending Co., Harrisburg, Pa.

Announcement has been received of the change of name of the Wayne Welding Co., Fort Wayne, Ind., to Wayne Welding and Supply Co.

GOOD WELDING *requires* GOOD VISION

Your best welder will do a poor job unless his goggles give him a comfortable, clear view of his work.

Duraweld Goggles help your men get the most out of your welding equipment. The Noviweld Lenses in these goggles give comfortable vision—with a clear view of working details—and without eyestrain. Noviweld is recognized as the standard protection against dangerous rays generated in welding.

Duraweld Goggles fit snugly, to eliminate any chance of flying particles getting in. Generous, light-proof louvers provide ample ventilation. The eyecup material is tough, moisture proof and does not conduct electricity. Duraweld goggles are easy to wear.

Give your welders good, comfortable welding vision with—

DURAWELD GOGGLES

patented

J480

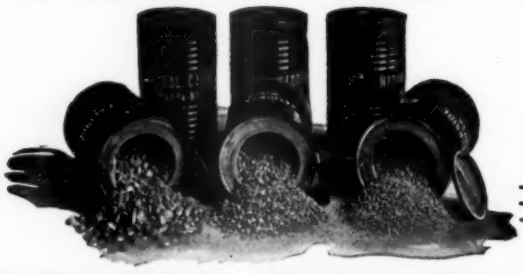
AMERICAN OPTICAL COMPANY

Southbridge, Massachusetts

SAFETY BRANCHES IN ALL PRINCIPAL CITIES

NATIONAL (TRADEMARK) CARBIDE

Quality Coke
Plus
Quality Limestone
Plus
Engineering Ability
Equal
National Carbide



National Carbide Sales Corporation
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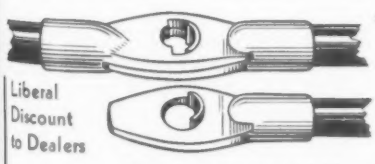
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